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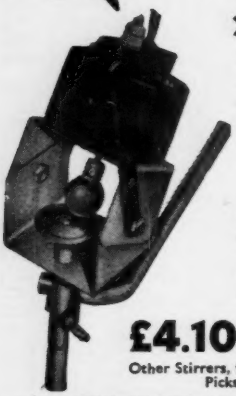

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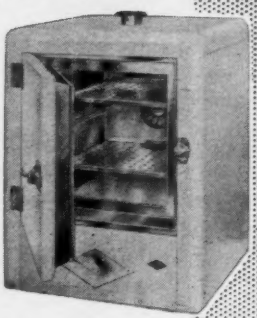

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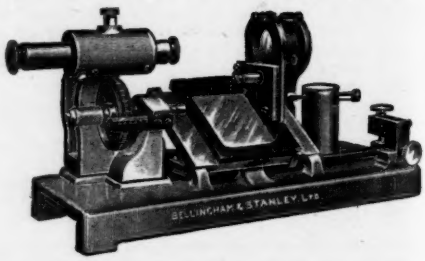

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HUMAN PROBLEMS OF INDUSTRIAL LEADERSHIP

THE brochure "New Developments in Industrial Leadership in Great Britain, the United States, Germany and France", which F. A. Heller has edited for the Polytechnic Management Association*, is based on four lectures and one discussion forum for directors and senior executives, organized by the Department of Management Studies of the Polytechnic, Regent Street, London. Even between the holding of the lectures in November 1954 and the publication of the brochure in December 1955, the importance of industrial leadership has been increasingly recognized and, in particular, its bearing on the introduction of new ideas into industry and the causes of resistance to change and the most effective ways of overcoming that resistance. This latter problem was discussed more specifically by Mr. J. F. Scott in his review of new aspects of management in the United States, although some of its implications were well indicated by Dr. J. A. C. Brown in surveying the British scene.

As Sir Geoffrey Vickers and Sir Walter Puckey point out in their introduction, Dr. Brown's lecture was designed to introduce the series and to set the whole problem of industrial leadership in its broad social as well as industrial context. None the less, the challenges he threw out were taken up by the subsequent lecturers, though Mr. F. A. Heller's survey of recent changes in industrial democracy in Germany illuminates especially the issues involved in joint management, and M. H. Hauck's review of modern management in private and nationalized industry in France touches on the role of the trade unions and of works committees. Both these lectures stress the structural and legal aspects of leadership, as against the psychological problems emphasized by Dr. Brown and Mr. Scott. In France and Germany, however, there is the same realization as in Britain and the United States that much of the psychology and sociology of the nineteenth century must be discarded, and that work will not be successful economically unless it is also a satisfactory social activity.

These last two papers describe some experiments which have been made in the reorganization of great industries in France and in Germany with the object of changing the situation to which the people concerned have to respond, and thus to encourage new attitudes to change. Apart from Mr. Scott's paper, there is little reference to training or education in this brochure; although the value of these activities is stressed by Sir Geoffrey Vickers and Sir Walter Puckey. The brochure is of value indeed chiefly for its clear indication of the primary issues rather than as setting forth precise action to be taken to overcome resistance to change or promote the spread of new ideas; and its importance has been accentuated with the coming of automation to the fore as an urgent and leading issue. Moreover, Dr. Brown's contribution is of no less relevance to the issues of nationalization, which he shows, as it is practised in Britain, has created problems of human relations which are yet unsolved.

Dr. Brown begins by directing attention to the main implications for industrial leadership of the Hawthorne researches of the late Prof. Elton Mayo. The most important factor in industrial productivity is the feeling of the individual worker that his work has meaning and that he has a useful and essential part to play in society. In ordinary circumstances, money is one of the least effectual of incentives. People should and usually do, in fact, like their work, and changes in the physical conditions of work which involve no basic change in the common assumptions of management can lead to no fundamental improvement. Workers judge managers by what they do and by their assumed intentions. Management has to develop the social skills which lead to its acceptance by working groups, and, in particular, to the coincidence of the natural discipline of the working group and the formal discipline of management.

Accordingly, even if money were as effective an incentive as some people suppose, the study of human relations is essential in the Welfare State, where income tax largely removes the stimulus of increased wages and unemployment is no longer a real threat, and also because in modern mass production group co-ordination is of the first importance and the factory manager is concerned less with technical skills than with the co-ordination of human activities. To-day, authority can only come from mutual agreement between management and worker, as in fact the recent dispute over the reorganization and re-tooling of tractor production at the Standard Motor Company's works at Coventry seems to show. It is true, as Dr. Brown points out, that the study of human attitudes and relations can be carried to excess and the ultimate purpose of labour—the satisfaction of the consumer's demands and needs—overlooked; but the British industrial tradition is, on the whole, to resist change, and there is also a widespread suspicion of the idea that one can establish and put into practice a technique of human relations. With some exceptions, Dr. Brown suggests that British managements have paid lip service to Mayo's researches while fearing to put their implications into effect, or doing so only half-heartedly.

The fundamental issue, as Dr. Brown sees it, is the establishment of greater trust between the two sides of industry. Unless mutual trust exists, works councils, for example, are a waste of time; and this question of trust is the more important in view of the suspicion of technology which characterizes British scientific tradition—especially when concerned with human beings—and of the way in which our respect for the individual discourages any suggestion that he can be further understood by investi-

* New Developments in Industrial Leadership in Great Britain, the United States, Germany and France. Edited by Frank A. Heller. Pp. 75. (New Development Series, No. 1.) (London: Polytechnic Management Association, 1955.) 5s.

gation or changed by new circumstances. As it is, Dr. Brown points out, while in Britain the workers are at present much better-off than anywhere else in Europe, there is more mutual suspicion between management and workers. Britain, in consequence, is more haunted by the past than many less progressive countries, and this is no less true of the nationalized industries than of private industry. In fact, Dr. Brown considers that whereas nationalization may have succeeded economically, in the human sense it has failed because it has not observed that ordinary individuals can only think in terms of people: the Trades Union Congress or the National Coal Board is without personal significance of any sort. It is probably true to say that the large privately-run concerns in Britain have shown a much greater tendency than nationalized industry to appreciate the dangers of over-centralization with its attendant bureaucracy, and have attempted to delegate authority to the local units.

The two criteria by which we must judge the industrial working group, namely, its productivity, and the social and psychological satisfactions which it gives its members, are not in contradiction but rather go together. Dr. Brown argues that the only possible solution of our problem to-day is that of treating people as human beings, giving them responsibility and trusting them to respond. Status and function within the society to which a man belongs are the most important things to him. Mr. Scott's review of the way this solution is being worked out in the United States, and particularly the emergence in the past fifteen years of a new national attitude towards the study of management and the selection of managers, indicate the possibility of altering the pattern of human relationships and thus overcoming the traditional barrier which custom offers to technical change. No society, he remarks, can survive that cannot find ways of evolving managers who are at once technically suitable to new needs and at the same time acceptable to those whom they must lead.

Mr. Scott emphasizes two points that seem to be of particular importance in regard to industrial leadership in Britain to-day, and especially where, as in the issues raised by automation, technical aspects are interwoven with and dependent on human relations. First, Mr. Scott notes that the concept of productivity should be applied to management in its human aspects, so that we give due weight to preventing human problems arising and are not occupied solely in trying to solve them as they arise. Then, as a consequence of the greater interest in the study of management in the United States, more and more of the managers of to-morrow are being consciously selected and trained, and more and more of them are accepted. That is most important both from the point of view of recruiting leaders from all ranks of society on the basis only of ability, and in order to reduce the time-lag between technical discovery and production. Secondly, he emphasizes the importance of understanding. The details are important, but it is the spread of understanding that really counts and enables technical change to proceed smoothly and at an increasing rate. If we in Britain could learn to make greater use of social science and apply it in a less materialistic and mechanical way than has sometimes been done in the United States, the difficulties in the introduction of automatic methods might be much less formidable.

These four papers should stimulate that further thought about industrial leadership and its functions which is needed as much on the trade union side as on that of management. It is not always realized how large are the demands for leadership made on the trade unions themselves, though the implications have been brought out by Mr. John A. Mack in an article contributed to the recent special issue of *The Political Quarterly* dealing with trade union problems. In a wider context, however, the implications of automation and of nuclear energy are well indicated by Dr. Alexander King in an article entitled "Science and the Changing Face of Industry—the Social Phase" in *Impact* of March 1956. Dr. King does not believe that the automatic factory is likely to become common within the next decade, but considers that automatic working will extend sufficiently to cause considerable industrial strain and to necessitate the tackling of many difficult social and managerial problems.

Although Dr. King covers a much wider field than automation, his article is an important contribution to the discussion of the problems which this latest extension of mechanization brings in its train, in that it sets those problems in the context of technical change generally and facilitates a clearer understanding of what is involved in the changing pattern of industry under the influence of science. Technical innovation can no longer be considered apart from the human factor, not merely from the point of view of technical education and the training of men and women in the skills required to operate new processes and to handle new materials: regard must equally be had to the effects on society as well as on the pattern and location of industry itself. Dr. King gives indeed clear warning that automation and nuclear power are not the only developments in which scientific discovery is changing the pattern of industry and of human institutions. It may well be that only revolutionary developments in, for example, photosynthesis may enable the problem of population and food supply, particularly in the under-developed areas, to be solved.

The outstanding challenge to-day is, in fact, to create the social and political institutions that will enable us to utilize the discoveries and techniques which science and technology have put at our disposal. Such developments cannot be considered from the point of view of a single scientific discipline or even of a single technology or industry. Just as the first need was for co-operation between the various natural sciences and engineering, so now the need is increasingly for co-operation between different industries, between all sides of industry, and between the social as well as the physical scientists. Economic and social factors may determine the rate of progress much more than the technological factors; and while at present the social sciences can, as Dr. King

observes, do little more than delineate the problems, in this third—the social—phase of industrial evolution, they may well play a more important part than the natural sciences or technology.

While the demands which nuclear power and automation will make on management for wise leadership are thus unmistakable, it should not be thought that that leadership is a responsibility of management or even of government alone. Technologists will indeed, as Sir Walter Puckey remarks, need to be more concerned with the effects of their work on the men and women concerned, and managers to give much more attention to human problems and to the problems of organization involved in using machines more intensively. Neither, however, can do their work effectively unless there is a wider appreciation on all sides of what is involved—the understanding stressed by Mr. Scott.

Accordingly, it is the more welcome to find Mr. Robert Edwards, member of Parliament for Bilston, speaking as a trade union general secretary at the Committee stage of the Restrictive Trade Practices Bill on May 3, and urging that we should not be afraid of short-term redundancy with the development of increased production; but that on both sides of industry, and on both sides of the House of Commons, we should face the social consequences of redundancy in the interest of the general standard of living of the people and in the interests of an economy moving towards abundance. Further evidence of readiness to consider the needs of the community as a whole rather than sectional needs in a particular industry was forthcoming when the Minister of Labour made his statement on automation on May 8. Replying to questions, Mr. Iain Macleod said that automation is the latest and most novel form of technological change, and is welcomed by the Government and responsible opinion on both sides of industry as essential to the future efficiency of Britain. The problems of re-deployment of labour and of the introduction of new skills involved can be satisfactorily solved, he said, if the Government and both sides of industry work in close co-operation. It is essential that firms contemplating the introduction of automation should in their planning consider the effect on their workers from the beginning and bring them into early discussion. For its part, the Government accepts a continuing responsibility for maintaining the general level of demand and, besides the provision for the extension of technical education already announced, it would provide opportunities for training and would assist through its employment services workers who had to change their employment. In the light of the imminent report from the Department of Scientific and Industrial Research, he said he proposes to discuss the whole question with representatives of the employers, trade unions and nationalized industries on the national joint advisory councils, and, as appropriate, with other advisory bodies. The Government is confident that if all concerned play their part in this way, these new changes will prove of immeasurable benefit to the nation.

These observations were welcomed by the Opposition in the House of Commons; and it was clear from the remarks both on May 8 and later, on May 10, when the Prime Minister was asked for a statement of policy, that both Government and Opposition welcome the development of this new technique but are both concerned as to its social and economic effects. Sir Anthony Eden, affirming the Government's complete support of a policy of full employment, said he is doubtful as to the expediency of consultation on the floor of the shop or factory rather than through the trade unions. He reiterated that a continual and steady improvement in our industrial techniques is necessary to preserve the competitive position of Britain in the world, to maintain full employment and to ensure a continuous rise in the standard of living. The Government hopes that industry will invest in the new types of machinery to the fullest possible extent, but simultaneously there must be joint consultations with industry at an early date so that the introduction of new methods may proceed without friction.

There is thus reason to hope that in spite of the dispute at Coventry, which has brought automation and its attendant problems to the notice of the general public, plans will be concerted in advance to reduce the difficulties and fears which many people understandably entertain about the consequences of technological change. Meanwhile, however, the Government's proposals for the expansion of technical education, and indeed the educational programme as a whole, should be scrutinized the more carefully with a view to their adequacy in providing not merely workers with the technical skill needed, but also citizens with the adaptability which an age of technological change demands of them as citizens as well as workers. Both technological and university education should likewise be examined for their ability to provide the leaders required not merely in industry but also in government and in trade unions. Nor must either management or trade unions delay in examining the appropriateness to modern conditions of their own practices, and the effectiveness of their present systems of recruiting and training leaders, and adapting policies or practices to new demands.

GUIDED MISSILES

Guidance

By Arthur S. Locke and collaborators. (Principles of Guided Missile Design Series. Edited by Grayson Merrill.) Pp. xvii+729. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1955.) 12.50 dollars; 90*s*. net.

DEVELOPMENTS in the theory, design and testing of guided missiles include some of the major contributions to military technology during recent years, and they are of considerable scientific interest. The nature of these developments, however, is such that security regulations have permitted only a limited amount of information to be published; and the proposed series of five books on the basic principles of the subject, of which this is the first volume, will constitute the first major published work.

The design of guided missiles involves many specialized fields. For example, the guidance of a missile introduces advanced problems in servo-mechanism theory, aerodynamics, radar, navigation and communications, and the application of analogue and digital computers. The present book covers the relevant principles of these subjects, albeit in an elementary, and occasionally disjointed, manner; this latter is to be expected since the work has been written by several authors, and the task of co-ordinating a subject with such a broad basis must have been extremely difficult.

The volume appears to have been written essentially for technical officers in the Armed Services, and civilian scientific personnel in defence and industrial laboratories engaged in the development of missiles. It will also provide a basic text-book for the more comprehensive postgraduate courses in guided missile technology which have been introduced at several Service colleges; and the specialist in any one of the topics mentioned above will find the book useful in providing a general introduction to the subject as a whole. On the other hand, it cannot be regarded as an authoritative text-book but rather as a reference work which will supplement the classified literature. The most important chapters are those dealing with terrestrial and celestial references; measurements of missile motion; detection and information gathering; missile guidance systems; and missile guidance bandwidth studies; because this material includes specialized topics which have not hitherto been described in the literature. In addition, the chapters on transmission of radio waves and servo-system theory have been well planned and presented, and they will give a newcomer excellent background material in these important subjects. Notwithstanding the brevity of the chapter on the missile airframe, the authors have included the derivation of the airframe transfer functions and their approximate representation in the form of Bode diagrams; this is a desirable step because it effectively bridges the gap between the essentially servo and the essentially aerodynamic aspects of the design problem. The historical introduction, outlining the development of anti-aircraft instruments and weapons and navigational systems, and the short chapters introducing tactical and economic considerations, will be of considerable interest to the military technologist.

In the attempt to cover so extensive a field in a single volume, several topics have been treated rather summarily, and in some cases the desirability of introducing them is questionable. The brief notes on mathematical methods, especially curve-fitting, probability theory, and correlation functions are inadequate and of little value, and various sections of the chapters on transmission of radio waves and on radar will be incomprehensible to readers having no previous knowledge of these subjects. Again, in the penultimate chapter, the brief notes on digital computers will tend to confuse rather than to clarify—it is not possible to describe a high-speed digital computer and to introduce the programming of the machine in four pages. But these are not major criticisms because, for the most part, the book is well written and gives a lucid account of the basic principles of missile guidance.

A noteworthy feature is the large number of well-conceived and excellently executed diagrams, which enhance and clarify a text that will be welcomed by all technologists interested in defence problems.

A. Porter

JUBILEE OF THE JOSIAH MACY, JR., FOUNDATION

The Josiah Macy, Jr., Foundation, 1930–1955
A Review of Activities. Pp. xii+174. (New York: Josiah Macy, Jr., Foundation, 1955.)

To medical research workers in Great Britain the Josiah Macy, Jr., Foundation is best known for its admirably planned conferences and conference groups of investigators in different disciplines but with common interests; the published reports of these meetings extend their value far beyond the small number of experts (usually twenty-five, including "at least one from abroad") who are able to attend them. The Foundation's policy of bringing together specialists in a variety of subjects and skills which may bear upon the topic chosen for discussion represents an enlightened interpretation of the founder's wishes that the trustees should pay special attention to "integrating functions in medical sciences and medical education for which there seems to be particular need in our age of specialization and technical complexities". The "Transactions" of the successive meetings dealing with topics as various as administrative medicine, the adrenal cortex, liver injury, neuropharmacology, problems of infancy and childhood, problems of ageing (appropriately the subject of longest study) and cybernetics, to name only a selection, represent important if inevitably rather diffuse contributions to the literature of these subjects. It is interesting to note that the idea of arranging such serial meetings developed from the Foundation's initiative in organizing conferences on medical subjects of urgent military significance during the Second World War, and from the desire then expressed by the groups of investigators attending the meetings concerned with rapidly developing research problems, such as wound healing and shock, to renew their consultations at intervals over a period of years.

The present book surveys the surprisingly wide range of activities of the Foundation during the quarter-century since it was established in 1930. In addition to the conference programme, these activities have included support for certain marginal and somewhat speculative investigations which might otherwise have languished, as well as for many subjects of more orthodox appeal. The review of these different activities is a little optimistic in its assessment of the studies aided (it is surprising, to say the least, for example, to find the whole story of the role of acetylcholine in the transmission of nerve impulses apparently attributed to one worker in the United States who has been assisted by the Foundation); but the Board of the Foundation is certainly to be congratulated upon the presentation of a very creditable account of its stewardship.

The present value of the Foundation's endowment exceeds 28 million dollars. In twenty-five years the Foundation has distributed more than 4,268,000 dollars as grants-in-aid (842 projects), and has spent more than 1,350,000 dollars on its conference programme and other operational activities. Naturally, the greater part of its resources is expended within the United States; but the report refers also to grants that have been made from time to time to investigators in Belgium, Canada, Denmark, France, Germany and Great Britain, as well as to various overseas conferences which have been subsidized. An investigation within Britain currently being

assisted by the Foundation is the study by Dr. John Bowlby and others at the Child Guidance Department of the Tavistock Clinic, London, of the effects upon personality development of the separation of young children from their mothers.

The guiding principle of the Foundation, in accordance with the expressed desire of Mrs. Walter Graeme Ladd, the founder, is to be interested in "the architecture of ideas". This is a lofty aim, and there is no cause for wonder if some of the ideas thus assisted prove ephemeral. Taken as a whole, however, the Foundation's solid achievement in stimulating and co-ordinating good research work constitutes an impressive memorial to Mrs. Ladd's father, after whom the benefaction is named.

F. H. K. GREEN

BRITISH UNIVERSITIES THROUGH AMERICAN EYES

Higher Learning in Britain

By Prof. George F. Kneller. Pp. xii+301. (Berkeley and Los Angeles: University of California Press; London: Cambridge University Press, 1955.) 45*s.* net.

"IT is obvious from what has been revealed in this volume", writes Prof. G. F. Kneller, "that the author sees a crisis, or better a critical situation, in the very intellectual substance of the writing which has appeared in the last few decades on university education *per se*." This writing, which is a native diagnosis of the British university system, Prof. Kneller does not commend. After an intensive examination of the literature on the "crisis", he finds it "impoverished and rapid", with "thinly-sown ideas", "worn-out and threadbare documentation" and based on "trite and nugatory educational fundamentals".

It is obvious that Prof. Kneller has little time for the rearguard skirmishers or the pessimists, for he regards their observations as "bickering". As an optimist who sees that "values in abundance prevail everywhere", he is obviously stimulated by the panorama of human interests and experiences in Britain that spring from the expansion of social, political and religious interests of the modern world. He sees in their interplay the very strength of the system. His sources of inspiration are basically scientific. A. N. Whitehead and (with reservations) J. D. Bernal are the stilts on which he lifts himself above despondency. His severest strictures are reserved for the purely 'arts' critic of our academic society. To him Sir Richard Livingstone is "uniformly vulnerable"; Dr. F. R. Leavis "verbally prolix", reflecting the "constricted modes of the nineteenth century"; Prof. M. V. C. Jeffreys "is not only unrealistic . . . but totally impractical" and Bruce Truscot "contradicts himself". As for Sir Walter Moberly, Prof. Kneller writes, "It is rudely evident, to say the least, that Moberly did not succeed in defining the crisis in the university, but rather described one situation which might be said to involve a crisis". For the bouts of academic fisticuffs that flared up around Sir Walter Moberly, Prof. Kneller provides a ringside commentary, recording each blow with painstaking accuracy. He has, by so doing, made his point clear that the real crisis in the university is "in the very intellectual substance of the writing which has appeared in the last few decades on university education *per se*".

Yet, though his sympathies are avowedly with the scientists and their claims, Prof. Kneller's ample bibliography and critical apparatus is singularly deficient on the scientific side. The *Economist* and *The Times Educational Supplement* are cited, but not *Nature*. Nor has he probed the influence of (among other bodies) the Advisory Committee on Scientific Policy, though he seems aware of its existence. Even when he does choose a scientist to adorn his story, he has to make him do the work of two. True, the present High Master of Manchester Grammar School probably can do this, but that seems no reason for giving him two separate identities in the index as "James, E. J. F., 232, 269 n. 12, 283" and "James, Eric, 92–3, 221, 257 n. 48, 261 n. 35, 283; quoted 93". This is running against the Ockhamite canon: *essentia non sunt multiplicanda praeter necessitatem*. Evidently the necessity was too great.

W. H. G. ARMYTAGE

MEYRICK'S MICROLEPIDOPTERA

Catalogue of the Type Specimens of Microlepidoptera

In the British Museum (Natural History) described by Edward Meyrick. By J. F. Gates Clarke.

Vol. 1. Pp. vii+332+4 plates. 60*s.*

Vol. 2: Stenomidae, Xyloryctidae, Copromorphidae. Pp. iv+531 (263 plates). 120*s.*

(London: British Museum (Natural History), 1955.)

THE first of these volumes introduces the reader to the peculiar problems arising from the vast number of species of Microlepidoptera described by Edward Meyrick (1854–1938). It gives an alphabetical list of the 14,199 names he gave them, and indicates the location of the type specimens. The second volume consists mainly of illustrations of the types (or newly designated lectotypes) belonging to three families, and it supplements Meyrick's original verbal descriptions with photographs of the left wings, photomicrographs of skilfully mounted preparations of the genitalia, and sometimes photographs or drawings of other structural details.

The author expects that four more volumes will be needed to cover the Meyrick types in London; he will then have laid the foundations on which detailed revisions of the classification can begin. It is indeed a herculean task which Meyrick left unfinished. For over half a century he dominated the study of these small moths. Collections from many parts of the world were submitted to him for naming and description. He described new species very methodically, but had an almost fanatical objection to the designation of types. This complete faith in verbal descriptions implied a belief that they were sufficient to distinguish new species not only from those already known, but also from those yet to be discovered. In a period when the science of entomology was rapidly advancing, his methods remained unchanged. Moths were still mounted on brass pins—now often corroded—and inadequately labelled. Wing venation was the prime character on which he based his classification, and shape, colour and markings were used in specific diagnoses. The genitalia were seldom examined, with the result that important structural differences were unobserved, and occa-

sionally the sex of specimens was mistaken. Gates Clarke claims that Meyrick's genus *Stenoma* is "one of the largest conglomerations of unrelated species ever brought under one name in the Lepidoptera". The illustrations of this genus in Vol. 2 show an astonishing diversity in the structures portrayed and will greatly help revisers of the group.

This pair of volumes is a landmark. It is a joint project of the United States Department of Agriculture, the Smithsonian Institution, and the British Museum (Natural History). The last-named authority is to be congratulated for the far-sighted decision to permit the dissection of so much type material. Would that comparable illustrated guides to the Linnaean and other great collections were available. The extension of this sort of work is vital to the understanding of the old descriptions of animals and plants, on which the stability of nomenclature depends.

Considering the quality of the production and the large number of excellent half-tone illustrations, the volumes are not expensive. Vol. 2 would have been more useful with an index and a table of contents, particularly since some species listed in Vol. 1 only under their original generic names are transferred to different genera in Vol. 2. G. C. Varley

GENERAL THERMODYNAMICS

Thermodynamics from the Classic and Generalized Standpoints

By Dr. Joseph Louis Finck. Pp. xv+224. (New York: Bookman Associates, 1955.) 7.50 dollars.

THIS book presents ideas which the author has developed over a number of years in papers published principally in the *Journal of the Franklin Institute*. These ideas relate to a study of thermodynamics from what the author calls a generalized point of view, which concerns itself with the thermodynamics of metastable states and irreversible processes as well as with the stable states and reversible processes of classical thermodynamics.

The author admits that the transition from classical to his generalized thermodynamics involves concepts which his readers may be reluctant to accept and, in order to facilitate this transition, he gives in the first half of the book a presentation of the subject-matter of classical thermodynamics, in which emphasis is placed on the limitations of the classical approach. This section of the book suffers from a confused presentation of the concept of heat itself, illustrated by the frequent appearance of statements such as "in an actual case when a force is applied to a body, heat is involved". This is the more unfortunate in a book in which the main theme requires a clear appreciation of the difference between the definition of heat in classical thermodynamics, and the layman's concept of heat, which usually includes vague ideas arising from phenomena associated with friction and other dissipative effects. It is, indeed, with these energy dissipative effects that the remainder of the book is principally concerned.

In the second half of the book the author introduces his own concept of a 'complete' system, in which the total number of independent variables required to describe the state of the system completely includes those which are beyond the control of, and the existence and variations of which may be unknown to, the observer. By this means the author claims to show how 'incomplete' systems acquire dissipative properties such as viscosity and electrical resistance, and why in some cases these properties vanish at very low temperature. The phenomenon of catalysis is among the other subjects studied.

Although the reader is certain to find cause for disagreement with the author in not a few places, and although he is unlikely to conclude that the author's presentation of 'generalized thermodynamics' has answered his own questions to the degree of satisfaction which the author claims for himself, the book is thought-provoking, and the author invites comments from his readers.

R. W. Haywood

NORTH AFRICAN PREHISTORY

Préhistoire de l'Afrique

Par Prof. Raymond Vaufrey. Tome 1: Le Maghreb. (Publications de l'Institut des Hautes Études de Tunis, Vol. 4.) Pp. 458+60 plates. (Paris: Masson et Cie., 1955.) n.p.

PROF. RAYMOND VAUFREY has written a magnificent monograph, profusely illustrated, on the prehistory of Algeria, Tunisia and Morocco, the "Isle of Maghreb". So rich is it in documentation that one can confidently assert that it is never likely to be entirely replaced. Prof. Vaufrey is a professor in the Institute of Human Palæontology, Paris, and he has visited and worked in North Africa repeatedly. He has also absorbed the very considerable literature on the prehistory of the area which has not infrequently seen the light in obscure journals not easily obtainable.

After an introductory chapter and another on the history of research in the region, the Lower and Middle Palæolithic periods are considered. Accounts of the geological conditions and deposits are given, and excellent half-tone and line diagrams illustrate the chapter. Next the main Capsian culture is dealt with. Here Prof. Vaufrey seems to have accepted the conclusion that, in spite of the presence of some pigmy flints in the levels, a connexion with the Perigordian must be postulated. Incidentally, as regards the pigmies, it has been suggested that in these more southern latitudes softwood trees occurred in much greater numbers than in France during the Perigordian period. Microlithic industries are indicative of composite tools, and the best material for hafts would surely be softwood. Pigmy flints, then, in the main Capsian levels may merely mean that in these regions softwood was of commoner occurrence than it was farther north. A chapter on the late Capsian and another on the early Neolithic follow, and the palæontology of the region is then considered. A chapter of general conclusions brings the book to an end.

As already remarked, the volume as a whole is a magnificent piece of work which will long remain the classic account of the prehistory of the "Isle of Maghreb". The drawings alone, some thousands of them from the pen of that acknowledged expert, the Abbé Bouyssonie, provide a corpus of information indispensable to the student. Prof. Vaufrey is to be congratulated on the production of such a magnificent contribution to the prehistory of Africa.

M. C. Burkitt

Antimetabolites and Cancer

Edited by Cornelius P. Rhoads. (A Symposium presented on December 28–29, 1953, at the Boston meeting of the American Association for the Advancement of Science.) Pp. vi+312. (Washington, D.C.: American Association for the Advancement of Science, 1955.) 5.75 dollars.

THE fact that the collection of papers given at this symposium in December 1953 provides a review of the field which is still, on the whole, up to date indicates the general high quality of the contributions.

Stimulating and informative papers by Hitchings, Burchenal, Mandel, Lansford and Shive, Parks and G. B. Brown review a great deal of the work which they and others have done on purine, pyrimidine and folic acid analogues as anti-metabolites, and describe what is known of their relation to the treatment of experimental and clinical malignant disease. Particularly significant in this connexion are papers by Skipper, and by Nichol and Welch, on the development of drug resistance following the administration of amethopterin and 8-azaguanine. Woolley ascribes the inhibition of growth of a spontaneous mouse tumour by analogues of 1 : 2-diamino-4 : 5-dimethylbenzene (a vitamin B_{12} precursor) to interference with the synthesis of B_{12} by the tumour. However, this hypothesis appears to be inconsistent with statements, made elsewhere in his paper, that transplanted tumours do not synthesize B_{12} but that, on the other hand, one of these tumours is better inhibited than the spontaneous tumour by the antimetabolites.

Informative papers on perhaps less well-known topics in the field are given by Nickell on plant tumours, by Totter on the effect of aminopterin on bone marrow, by Visser on the use of nucleoside and nucleotide analogues as anti-metabolites, by Nelson on fœtal abnormalities following the administration of anti-metabolites and by Weinhouse on the carbohydrate metabolism of tumour cells.

This book provides an excellent review by experts of the state of knowledge on the subject covered by the title.

G. M. TIMMIS

Mumps, Measles and Mosaics

A Study of Animal and Plant Viruses. By Dr. Kenneth M. Smith and Dr. Roy Markham. (New Naturalist Special Volume.) Pp. xii+160+20 plates. (London: William Collins, Sons and Co., Ltd., 1954.) 18*s*. net.

THIS is a serious study of animal and plant viruses. In common with other books in the "New Naturalist Series", it deals with its subject authoritatively, yet in a manner which is easily comprehensible to any reader with a reasonable background of general science. Drs. K. M. Smith and R. Markham explain the results of their researches, some of which are quite dramatic, in clear language, and they write compellingly of the work of others. Thus, the book deals with the gradual discovery of the very small size of viruses, of their unique methods of propagation, of the extraordinary relationship of many viruses with insects and "above all, of their border-line status between life and not life".

It is only twenty years since man saw a virus for the first time and only sixty years since the very existence of such things was first suspected. The authors describe how the electron microscope has shown us the shape and appearance of many of the viruses. A large part of the book deals with plant viruses, with particular reference to their importance in horticulture and agriculture; but there are also chapters on virus tumours and the control of virus diseases. Of particular interest is a section on everyday virus diseases, which should prove to be valuable to students of medicine, hygiene, public health and epizootics.

There are a useful glossary and a table giving methods of testing for common plant viruses. Many practical methods, useful for the university student, are given in the later part of the book. A good bibliography of references is appended to each chapter. The book is generously illustrated with electron micrographs and diagrams. The four colour-photographs, which show the effects of plant and animal viruses, are particularly effective.

W. L. SUMNER

Statistics of Therapeutic Trials

By Dr. G. Herdan. Pp. xvi+367. (Amsterdam: Elsevier Publishing Company; London: Cleaver-Hume Press, Ltd., 1955.) 50*s*.

DR. G. HERDAN is primarily a statistician, being lecturer in statistics in the Faculty of Medicine in the University of Bristol. His book deals with a subject which has become very important in recent years and is the first book of its kind. It is intended for the use of physicians who wish to draw statistically valid conclusions from observations of the effects of therapy.

The book opens with a statement of fundamental principles which is not easy to read, but not essential to the understanding of what comes later. Diseases are divided into acute diseases, which are best studied by comparing one group of patients with another, and chronic diseases, in which it is sometimes possible to obtain information by calculating the regression coefficient of some measurement against time and comparing the results obtained in the same patient before, during, and after treatment. The appropriate statistical methods are described, and illustrative examples are worked out.

Special sections are devoted to studies of the treatment of pneumonia, poliomyelitis, scarlet fever, diphtheria, typhoid fever, and pneumococcal meningitis, as examples of acute diseases. The chronic diseases which are used as illustrations are cancer, pulmonary tuberculosis, rheumatoid arthritis, congestive heart failure, hypertension, diabetes and nephritis. Statistical studies of the treatment of all these diseases are discussed and it is surprising what a large number of the actual data come from the German literature. The book is attractively produced and could be read with profit by many physicians.

J. H. GADDUM

The Cytology and Life-History of Bacteria

By Dr. K. A. Bisset. Second edition. Pp. xii+164. (Edinburgh and London: E. and S. Livingstone, Ltd., 1955.) 25*s*. net.

UNTIL recently, bacteriology as a science has suffered from excessive parochialism, in that bacteria have been studied primarily because of their medical, industrial or agricultural importance. Dr. K. A. Bisset pointed out in the preface to his first edition that he was concerned to present the case "for regarding bacteria as living cells with the same structure and functions as other living cells", and in the second edition he incorporates evidence on this point which has been made available by technical advances during the past six years, such as the

cutting of ultra-thin sections of bacteria for examination in the electron microscope.

The general plan of the book is unaltered, with sections on techniques, surface structures, the bacterial nucleus, reproduction and sexuality, life-cycles in bacteria, macroformations, and evolutionary relationships. The final chapter, on the genetics of bacteria, is unsatisfactorily short, and the subject would surely be better considered in relation to the chapters on nuclear structure and development. The number of illustrations has been considerably increased, and almost all of them are excellent and illustrate clearly the points at issue.

This monograph contains much that is stimulating, and it brings together a great deal of evidence which shows quite clearly that, despite their small size, bacteria are cells of considerable complexity. It is a pity that the author has in places adopted a rather over-enthusiastic style which detracts somewhat from the value of the book as a whole. C. S. Cummins

The Sun and its Influence

An Introduction to the Study of Solar–Terrestrial Relations. By Dr. M. A. Ellison. Pp. xii+235+9 plates. (London: Routledge and Kegan Paul, Ltd., 1955.) 21*s*. net.

THE subject of solar–terrestrial relationships is one that has not always been well served by authors. It is a pleasure to welcome in this book an addition to the literature which gives the verified facts and indicates their possible significance while eschewing speculation.

Dr. M. A. Ellison uses his first three chapters in describing the Sun: its radiation, the structure of its atmosphere, and the activity therein that is associated with the terrestrial effects to be described later. Solar reactions on the ionosphere, on the Earth's magnetic field, on radio propagation and on the polar aurora are then dealt with in some detail; and the last two chapters are concerned with the Sun's radio emission and the problem of cosmic rays. It is perhaps disappointing that no mention is made of the weather—if only to dispel some of the widely held beliefs connecting its vagaries with sunspots, for which the evidence is insufficient or even non-existent.

The author's approach presupposes no more than 'school-leaving physics', and within this limitation he has achieved his object of introducing to the reader a fascinating subject that covers many widely different fields. The expert will not, of course, find his own subject treated exhaustively; but the astronomer will turn with interest to the geophysical sections and the geophysicist to the astronomical chapters, and the layman with a wide general interest in science will read the whole book with pleasure and profit. A. Hunter

Manual of Malayan Timbers

By H. E. Desch. Volume 2. (Malayan Forest Records —No. 15.) Pp. ix+329–762+plates 70–127. (Singapore: Malaya Publishing House, Ltd., 1954.) 15 Malayan dollars.

AS is explained in the foreword, this volume is the product of more than ordinary travail. Much of the original script was lost in 1942; but, after enlisting the support of Prof. Tanakadate, who was responsible for the publication of the "Foresters' Manual of Dipterocarps", by the late C. F. Symington, the author was enabled to rewrite most of it in Japanese prison camps between 1943 and 1945.

The format of the book follows that of Vol. 1, which was published in 1941. It is divided into sections, each dealing with one family, beginning with the Melastomaceae and proceeding alphabetically to the Winteraceae, with an additional section on the Coniferae. The scope of the work, originally intended to comprise only what was generally understood by commercial species, was eventually enlarged to contain any tree of which botanically authenticated material was available for study. The book includes a description of the wood of some four hundred different species, with details, wherever available, of weight, texture, durability, macroscopic features, mechanical, working and seasoning properties, amenability to preservative treatment, defects, importance and uses. Among the appendixes there is a most valuable bibliography listing 308 references.

The publication is well produced, and there are remarkably few printing errors. Some of the plates could have been better prepared and reproduced, but this is not the fault of the author. A revision of this manual may eventually become desirable, but this monumental compilation of data will remain a standard reference for many years to all who are interested in the timbers of South-East Asia.

Proceedings of the First International Symposium on Condensation Nuclei at Dublin, April 1955.

Edited by Mario Bossolasco. (*Geofisica Pura e Applicata*, Vol. 31; 1955/II.) Pp. 202. (Milan: Istituto Geofisico Italiano, 1955.) n.p.

THIS volume contains twenty-six papers dealing with techniques for measuring the concentration and size of Aitken nuclei ($5 \times 10^{-7} < r < 2 \times 10^{-5}$ cm.), their diffusion and coagulation, with the artificial production of these nuclei, and with related physiological studies.

A number of instruments based on the Nolan–Pollak counter, which measures nucleus concentrations by allowing them to become centres of condensation and measuring photo-electrically the extinction of a parallel-light beam by the fog, are described, but a novel modification by Rich which allows of size discrimination deserves special mention. R. Fürth contributes a valuable paper on the theory of diffusion and sedimentation of nuclei in a cylindrical container; this is used to good effect by Pollak and O'Connor in their experimental investigations of aerosol decay, from which they obtain information on the concentration, size and mass of the nuclei as a function of time. Two papers will be of particular interest to cloud physicists: Vittori describes the use of microchemical methods (Liesegang reactions) for the detection of atmospheric aerosols, especially chloride particles; Day presents some measurements of nucleus concentrations made over southern England and over the sea from an aircraft.

It is, perhaps, a little surprising that the main emphasis at this conference should have been upon the small Aitken nuclei when the larger aerosol particles are currently of greater meteorological interest. It is hoped that future conferences will pay more attention to the larger end of the spectrum and to such topics as the production, constitution and origin of atmospheric aerosol. However, this first meeting has produced a valuable set of papers, in the preparation and publication of which the organizers have achieved a high standard.

B. J. Mason

THE PERKIN JUBILEE CELEBRATIONS

THE discovery of mauve by W. H. Perkin in 1856 had consequences reaching so far beyond the dye-making and dye-using industries that, while the celebration in London of the centenary was fittingly initiated by the Society of Dyers and Colourists, the celebration was appropriately sponsored also by the Royal Society, the Chemical Society, the Society of Chemical Industry, the Royal Institute of Chemistry and the Association of British Chemical Manufacturers. The proceedings opened on May 7 with a reception to the principal overseas guests at the Tallow Chandlers' Hall, and on the following morning the Perkin Exhibition at the Science Museum, South Kensington, was opened by Dr. R. P. Linstead, to whose part in establishing the structure of the phthalocyanines Sir Robert Robinson, who presided, paid a happy tribute. Dr. Linstead, before declaring the exhibition open, made two points. Emphasizing Perkin's youth and initiative, he referred to the danger of so over-organizing research that initiative and enterprise are discouraged if not suppressed. Secondly, he stressed the remarkable speed with which Perkin's discovery was brought to production, and remarked that this also has its meaning for us to-day. Besides illustrating the attendant circumstances of the discovery and the subsequent development of the industry, the exhibition included a number of interesting letters from contemporaries of Perkin.

The main feature of the celebration was a series of four lectures which dealt with different aspects of Perkin's discovery and its results. In the first of these, Prof. John Read surveyed the life and work of Perkin, presenting a vivid picture of the scientific and technical setting in which the discovery was made, and bringing out above all the human qualities of the young chemist who made it, the difficulties which he had to overcome and the magnitude of his pioneering effort, not only in manufacture but also in the application of the new colouring matter. Moreover, Prof. Read was careful to portray not merely Perkin as the discoverer and manufacturer of mauve but also his subsequent career as a research chemist, in the course of which his synthesis of coumarin was a step towards the beginning of the synthetic perfume industry, as the reaction known by his name later permitted von Baeyer's synthesis of indigo; Perkin's deep interest in religion and in music was also emphasized.

In the second lecture, on May 9, Mr. Clifford Paine, development director of Imperial Chemical Industries, Ltd., drew on his forty years experience in the dyestuffs industry to give a masterly account of the development of the dyestuffs industry since Perkin's day, in which the principal features were indicated in a way readily intelligible even to a non-technical audience. Mr. Paine noted the way in which the industry has turned full circle in that, while Perkin's mauve came from an unsuccessful attempt to prepare quinine, the discovery of paludrine at Blackley has rendered the synthesis of quinine of no pharmaceutical importance. To recapitulate the outstanding advances of successive decades would not do justice to an address which abounded in touches, as in the references to the level of research expenditure and the difficulties over laboratory glassware in the First World War, which were obviously based on Mr. Paine's personal experience. A moving moment in the celebrations was when Dr. Herbert Levinstein, who had been managing director of Levinstein, Ltd., when Mr. Paine joined the firm, and was the sole living link with the jubilee celebrations of 1906, rose to express the thanks of the audience.

Mr. Paine himself presided when, on the afternoon of May 9, Mr. J. G. Evans, technical director of the Bradford Dyers Association, read a paper on "The Tinctorial Arts To-day". Mr. Paine reminded the audience that a quarter of a century earlier Mr. Evans had assisted Prof. H. E. Armstrong in his lecture "At the Sign of the Hexagon" in the same lecture theatre of the Royal Institution, and on asking for guidance as to the order of the demonstrations had been instructed to "Use your intelligence, man". Mr. Evans began by reading Perkin's original patent and, enlarging on the dyeing materials at the disposal of the dyer in Perkin's day and the available techniques, stressed the importance of Perkin's contributions in the application of mauve and allied dyestuffs. These contributions were even more important than the discovery of mauve itself and have remained in use to-day long after mauve has been superseded. Mr. Evans indicated the way in which new dyestuffs and changing requirements for fastness have set new problems for the dyer, and referred particularly to the problems arising from the advent of new fibres and new dyestuffs. To meet the demand for increased productivity, continuous methods of dyeing are being introduced, and Mr. Evans mentioned the limits within which such methods are applicable. The vote of thanks was moved by Mr. C. M. Whittaker, who, like Mr. Evans, was originally engaged on the dyemaking side of the industry before becoming connected with the dyers, and who took the opportunity to stress the part which co-operation between the makers and users had played in the renaissance of the British dyestuffs industry.

Sir Alexander Todd's lecture on "The Development of Organic Chemistry since Perkin's Discovery", delivered on May 10, drew the smallest audience; but his fascinating survey was fully as intelligible to a non-technical audience as the three preceding lectures. Enlarging on the position of organic chemistry at the time of Perkin's discovery, only four years after Frankland's introduction of the idea of valency had given organic chemistry, or the chemistry of carbon compounds, a chance to grow, Sir Alexander gave his own view of the few simple conceptions which made the modern edifice of organic chemistry possible: Kekulé and Couper's independent introduction of the idea of the combining capacity of quadrivalent carbon atoms; Butlerow's postulate that structure determines properties; Kekulé's benzene ring structure; and the ideas of van 't Hoff and Le Bel regarding stereoisomerism, with Thiele's theory of partial valency. In the past fifty years, the major influences on the development of organic chemistry have come from physics, and in the last fifteen years dynamic aspects especially have been to the fore.

Sir Alexander emphasized the close connexion, in the latter half of the nineteenth century, of the development of organic chemistry with the rise of chemical industry, and showed how in this field science and industry have worked hand in hand. He believes that the future of industrial organic chemistry is assured, though he foresees no radical departures. While in the latter half of the nineteenth century there were few chemists working on the chemistry of living matter, in the past fifty years there has been a striking return to the original objectives of organic chemistry, and, thanks largely to new experimental techniques, academic organic chemistry may well be on the threshold of striking developments, especially in the natural products field. We now have the necessary knowledge and technique to embark on the study of such problems as the relation between chemical structure and biological action and the mechanism of biological action with reasonable hope of success. Organic chemistry, without doing the job of biology or becoming a mere handmaid to biochemistry, is likely to continue to be concerned, as was Perkin, with the natural products.

The form of the centenary celebrations thus differed considerably from that of the jubilee celebrations in 1906. The presence of Dr. Levinstein provided a living link, as already noted, and the reception at Guildhall on May 8 and the banquet on May 9 gave some measure of resemblance, and especially in the international character of the gathering. Lord Salisbury, in his tribute to Perkin, stressed appropriately the importance to Britain of being alert to make the fullest and speediest use of existing knowledge, as well as being active in research, and Mr. Paine, in proposing the toast of the guests, contrived a happy reference to the British industry's Perkin medallist, the late Mr. J. Baddiley.

Nevertheless, the celebrations, for all the excellence of the lectures, left a certain sense of disappointment or frustration, and this bears on a further feature which the jubilee and centenary celebrations have in common. In 1906 a Perkin Research Fund was established and is administered by the Chemical Society. In connexion with the centenary celebrations, it is hoped to raise £100,000 to found Perkin Centenary Scholarships designed "to promote, advance and encourage technical education in relation to all aspects of the fabrication or application of colouring matters". The proposal is timely, and Lord Salisbury's speech was well calculated to commend it. Not only was that speech, however, unnoticed in the daily Press, but also the whole opportunity which the centenary celebration offered of commending a career in technology to youth was ignored. That opportunity is not likely to recur speedily, and the excellence of the lectures testifies to what was missed. It is easy to suggest reasons for the comparative seniority of those present, though equally easy to suggest ways in which youth might have been encouraged to attend to receive inspiration. But the contrast between the treatment by the Press of the celebrations in 1906 with those of 1956 suggests some neglect of responsibility. *The Times* could find nearly three columns for the proceedings at the Royal Institution and the banquet in 1906; but in 1956 neither lectures nor the Lord President of the Council received a line. The *Manchester Guardian* published an admirable supplement on the centenary, but did not report the celebrations, and only in *The Times* was there a brief note of the exhibition at the Science Museum. Yet the fine-chemical industry is of even greater significance now than it was in 1906. Without the imaginative co-operation of the Press, it seems idle to hope that youth can be brought to realize the opportunities which technology offers, or public support and understanding secured for the expansion of technical and technological education that Britain's economic future demands.

RESEARCH ON THE HUMID TROPICS

THE UNESCO PROGRAMME

In the humid tropical regions, as in other parts of the world, the development of the land to meet the needs of rapidly growing human populations and the ultimate attainment of a satisfactory equilibrium between man and his environment, depends on scientific research. The need for fundamental research is especially great in these regions, partly because scientific activity has been centred mainly in the temperate zones and partly because so much of the research which has been done in the tropics has been applied and short-term in its aims. To-day the need for research on the problems peculiar to the humid tropics is particularly urgent, not only because there as elsewhere populations are rapidly outgrowing their food supplies, but also because at a time when large areas of tropical Africa and Asia are passing from a Colonial to a more or less independent status, countries which formerly depended on Colonial powers for the staffing and impetus of their research programmes will in future try to depend wholly or to a large extent on their own resources. For this reason, and because a great many of the scientific problems of these regions are world-wide or at least common to more than one country, the help of United Nations specialized agencies such as the World Health Organization, the Food and Agriculture Organization and the United Nations Educational, Scientific and Cultural Organization is both timely and necessary. Unless stimulus and support are given to fundamental research in the humid tropics by powerful international bodies, research in such countries is likely, for political and economic reasons, to be even more narrowly 'applied' and *ad hoc* in the future than it has tended to be in the past.

It was considerations of this sort which prompted the proposal that Unesco should develop a programme to assist research in the humid tropical regions parallel and complementary to the programme which it initiated in 1951 for research on the arid regions. The proposal was approved at the eighth session of the General Conference of Unesco held at Montevideo in November 1954, and in accordance with the resolutions of the Conference a preparatory meeting of specialists in humid tropics research was held at Kandy in Ceylon during March 22–24 last. Since

many of the most urgent problems of the humid tropics concern deforestation, erosion and land-use generally (and are therefore in the broadest sense of the word ecological), it was thought appropriate that the preparatory meeting should be preceded by a symposium on "The Study of Tropical Vegetation". This took place at Kandy and was held during March 19–21. The preparatory meeting was attended by delegates from Brazil, Ceylon, France, Holland, India, Indonesia, Pakistan, the Philippines, the United Kingdom and the United States, as well as by representatives of the specialized agencies of the United Nations (Food and Agriculture Organization, World Health Organization and World Meteorological Organization), of several international scientific unions and associations and of the Unesco secretariat. Several members of the preparatory meeting also took part in the symposium, but not all the twenty-one members who presented papers to the latter attended the meeting.

At the symposium twenty-two papers on tropical vegetation were presented, and the term 'humid tropics' was so widely interpreted that some papers dealt with regions of relatively dry climate such as Madhya Pradesh in India for which 'seasonal' might be a better description than 'humid'. Since the contributions to the symposium will be published by Unesco (it is hoped later this year), it is unnecessary to summarize them here; but it may be noted that the subjects covered ranged from vegetation mapping and the application of aerial photography to the survey of tropical plant communities to the cyto-genetical analysis of the forest flora of south-eastern Asia. The papers were circulated in advance and were not read in full, the authors being asked merely to introduce them briefly and to answer questions. This excellent plan left plenty of time for discussion and was undoubtedly largely responsible for the success of the meeting. The many lively discussions were skilfully guided by the chairman, Dr. C. H. Holmes, of the Ceylon Forestry Department.

In addition to the presentation and discussion of papers, which took about half the available time, discussions were held on five general themes chosen by a steering committee. Each theme was introduced and summed up by a chosen speaker, as follows: ecological factors in the tropics with special reference to the definition of dry seasons (Prof. G. Mangenot, France), vegetation types and their subdivisions, including methods of study (Prof. F. R. Bharucha, India), vegetation mapping (Dr. F. R. Fosberg, United States), the concept of the climax as applied to tropical vegetation (Prof. P. W. Richards, United Kingdom) and regeneration as a factor in judging the status of vegetation types (Prof. C. G. G. J. van Steenis, Holland). The discussions left no doubt of the vigorous activity and lively interest in the field of tropical ecology. There was a general feeling that the methods and concepts of ecology are too largely based on experience in temperate countries, where the vegetation has been modified by human activities for a very long period of time. This point of view was expressed perhaps most forcibly by Prof. van Steenis in a paper dealing with the basic principles of plant sociology as applied to tropical rain-forest vegetation. He claimed that homogeneous samples such as current plant sociological methods require cannot be found in rain forest of the usual type, while the concept of the plant association as a unit of constant composition and definable boundaries is one which could have evolved only in temperate regions with their impoverished and specialized flora and largely anthropogenic plant communities. "If plant sociology had been developed in a tropical country," he said, "it would have another face to-day. In fact the whole of botany would have another face if it had developed in the tropical zone." It is clear that the study of tropical vegetation is likely to develop rapidly in the near future, and that the proposal of some of the Indian members of the symposium to found an international society for tropical ecology is likely to be widely welcomed.

On the afternoon of its third day the symposium adopted a series of resolutions aiming at the promotion of ecological research in the tropics. These were presented to the preparatory meeting, which endorsed them and forwarded them to the Director-General of Unesco.

The preparatory meeting of experts on humid tropics research elected Mr. D. Rhind, secretary of the Committee for Colonial Agricultural Research (Colonial Office), as its chairman. Its main purpose was to propose the formation of a permanent advisory committee of Unesco for humid tropics research and to define the scope and method of functioning of this committee. Some discussion took place on the exact meaning of the term 'humid tropics', which is difficult to define, since there are large parts of the tropics which receive a heavy rainfall unevenly distributed through the year so that the climate is only seasonally humid. It was finally decided that a rough line of division should be drawn in agreement with Unesco's Arid Zone Committee, so that there should be no overlap and no omission of intervening regions from the field of interest of either committee.

There was also discussion on the meaning of 'fundamental research'. Though the general feeling seemed to be that the main duty of the proposed committee should be to provide or initiate research on the basic underlying scientific problems of the humid tropics, some members were opposed to defining its field in such a way as to exclude all kinds of 'applied' research. Careful consideration was given to avoiding overlapping with other international organizations concerned with research such as the Food and Agriculture Organization, the World Health Organization and the Commission for Technical Co-operation in Africa South of the Sahara ('C.S.A.'). There were certain fields of research such as geology and human health and physiology under humid tropical conditions which the meeting considered were probably adequately cared for by existing organizations, but which it was unwilling to exclude formally from the field of interest of the proposed committee.

Papers on an enormous range of subjects covering such diverse fields as zoological surveys, coral atoll ecology, reclamation of swamp land in Brazil, pedology, climatology, research on medicinal plants and much else were laid before the meeting, as well as requests for financial support to various research projects, several of which were recommended to the Director-General of Unesco for favourable consideration. A remarkable feature was the number and diversity of the requests for more taxonomic work on both plants and animals (especially insects) in the tropics. Many speakers made it evident that the lack of modern Floras and other taxonomic works for many tropical countries is at present an insuperable hindrance to research in a great many fields. The remedy depends on trained man-power as well

as on finance; but it is clear that the belief that the biological sciences in the tropics can progress in the absence of strong support to taxonomy is quite unrealistic.

The preparatory meeting accepted gratefully an invitation from the delegate for France that the new Humid Tropics Advisory Committee, which Unesco has been asked to set up, should hold its first meeting, if possible in 1957, at Abidjan in the Ivory Coast. At the symposium on tropical vegetation it was recommended that this meeting should be preceded by another symposium with the theme "Ecological Studies of Tropical Vegetation in Relation to Soils".

P. W. Richards

GEOCHEMICAL AND GEOPHYSICAL LABORATORIES IN THE IMPERIAL COLLEGE

By Prof. DAVID WILLIAMS

ONE of the initial steps towards the goal of full expansion of the Imperial College of Science and Technology, London, has been the addition of a top story to the Royal School of Mines. This story, incorporated in the Department of Geology, provides about 11,000 sq. ft. of accommodation for the Sub-departments of Geochemistry and Applied Geophysics, which are mainly concerned with training and research in certain modern aspects of mineral exploration. The new laboratories were open to inspection on May 24.

The Geochemistry Section comprises a main laboratory for the chemical analysis of minerals, rocks and soils, two laboratories devoted to spectrochemical analysis and the study of trace elements in geological material by means of large quartz spectrographs and other modern instruments, together with sample preparation and balance rooms. X-ray equipment for mineral identification is available, and a mass spectrometer is shortly to be installed. Several research cubicles are provided for postgraduates engaged in the investigation of a wide range of problems in pure geochemistry and geochemical prospecting.

Analysis of silicate rocks by the so-called classical methods is a protracted and highly skilled technique. Fortunately, however, rapid spectrochemical methods of silicate analysis, recently devised in the United States and substantially modified as the result of research in the new Pure Geochemistry Laboratories of the College, now permit a productivity of ten complete and reliable analyses per man-week. Thanks to this increased tempo the Department has been able to make comprehensive studies of the chemical changes induced in sediments by the emplacement of granites in Donegal, and to investigate chemical variations in the serpentinized basic igneous rocks of Insch in the Scottish Highlands. The research programme in pure geochemistry also includes a comparison of different analytical procedures, using spectrographic, polarographic, chromatographic and colorimetric techniques. This study should indicate the most appropriate method to adopt for determining particular elements, and it is hoped eventually to offer interested workers in other universities and research establishments a variety of silicate rock powders of guaranteed major- and minor-element composition.

Although much is known about the partitioning of certain elements among different minerals and among varieties of particular species, little research has yet been concentrated on the geochemistry of the less common metals, including those of the rare-earth group. Timely investigations, however, are now under way in the new Department concerning the distribution in minerals of cerium, gadolinium, terbium and other rare-earth elements, knowledge of which will be especially valuable in view of the increasing interest in atomic energy. Regional studies of the distribution of trace elements in specific ore minerals continue to receive attention, and the dispersal of certain elements throughout soil profiles in temperate regions is under consideration. A virgin field of attractive research in nuclear geology awaits the arrival in the Department of a mass spectrometer capable of determining the isotopic abundance of a wider range of elements than has hitherto been investigated anywhere. Among the many problems to be studied is the isotopic constitution of copper, zinc and other metals within a single sulphide deposit and within a particular mineralized district, an inquiry which should not only shed light on the origin of the deposits but may also herald a novel approach to mineral exploration.

In applied geochemistry, a flourishing research school is primarily concerned with critical studies of existing methods of geochemical prospecting, with the development of new field and laboratory techniques, and with the fundamental principles involved in the formation and detection of geochemical anomalies of economic significance. Geochemical methods of prospecting rely on the presence of significant traces of metals naturally dispersed in the rocks and soils near an ore-body, in the vegetation growing on these soils, or in the waters and sediments of streams draining the mineralized area. Thus, although there may be no visible manifestations of mineralization, the presence of concealed mineral deposits may be revealed by the detection of anomalous concentrations of metals in surface materials. Since the concentrations involved are usually very minute, rapid and simple trace analytical techniques have been specially devised to detect them. A Geochemical Prospecting Research Centre has been established in the Department, partly with the aid of funds from the Colonial Office and the Department of Scientific and Industrial Research, and active research is being carried out in various parts of Africa and Britain in mineralized areas containing cobalt, copper, gold, lead, zinc and other metals. Results to date augur well for the continued success of this new method of discovering minerals.

The Applied Geophysics Department is provided with a diversity of modern prospecting instruments, including vertical and horizontal magnetometers, a Worden and a North American gravity meter, seismic equipment and a variety of electrical instruments for spontaneous polarization, resistivity and elector-

magnetic surveys. Facilities are available for testing and calibrating these instruments and also for measuring some of the relevant physical properties of rocks and minerals. In the students' laboratory model experiments, simulating field conditions, have been developed to illustrate many of the principles employed in geophysical prospecting. A main laboratory and a number of small ones are devoted to research, and a workshop affords facilities for the construction and development of special equipment.

Current research in geophysics includes gravity-meter surveys along the margin of a gabbro mass near Insch in Scotland, and the development of an automatic method of computing the gravitational effects of various types of geological bodies. Studies of Tertiary igneous rocks in Mull and North Wales have indicated that during their extrusion or intrusion many of these rocks were magnetized in a direction opposite to that of the Earth's present field. While any theory of the Earth's magnetism must account for this adverse magnetism, possibly by invoking a reversal of the Earth's field in the geological past, the results obtained in these academic studies have an obvious bearing on the geological interpretation of magnetic surveys for mineral deposits. An attempt is now being made to use the techniques of palæo-magnetism for studying the physical conditions which operated during the emplacement of granites and the injection of dykes.

On the instrumental side a flux-gate magnetometer (of the type used in aeromagnetic surveying) is being modified for use at sea, to be towed behind a ship; with this instrument it is hoped soon to make magnetic measurements in the North Atlantic. Development of a novel type of magnetometer based on nuclear magnetic resonance is expected to result in the speeding up of magnetic surveys on land, the instrument consisting essentially of a bottle of water, an electromagnet and a detector coil to measure the frequency of proton precession.

Seismic research is directed towards the production of simpler and more reproducible shocks, using an electromechanical device. Investigations, particularly of frequency attenuation and phase changes, are being continued and the new technique should prove valuable in helping to decipher shallow geological structures. Promising results have attended the evolution of an induced polarization method of locating good conducting ore-bodies enveloped by an electrolyte, and equipment is now being constructed for field-trials over known metalliferous deposits.

OBITUARIES

Prof. S. R. K. Glanville, F.B.A.

STEPHEN RANULPH KINGDON GLANVILLE, Provost of King's College, Cambridge, and Herbert Thompson professor of Egyptology in the University, died, very suddenly, on the morning of April 26, his fifty-sixth birthday. The news of his death came as a great shock, not only to his professional colleagues, but also to men and women in many countries; for there were few who knew him who did not come to rely on him for friendship and sympathy.

Glanville was the eldest son of Stephen James Glanville and was born in Westminster in 1900. He was educated at Marlborough and at Lincoln College, Oxford, where he was a modern history scholar. He graduated in Literæ Humaniores in 1922. Chance largely led him to accept a post as an English teacher in the Egyptian Delta town of Mansūrah. Once there, he fell in love with the country and its people, and set himself to study them. He joined the Egypt Exploration Society's excavations at Tell-el-Amarneh in the season of 1923, the beginning of his long record of devoted service to the Society as a field-worker, and as member and chairman of committee. In 1924, he was appointed an assistant keeper in the Department of Egyptian and Assyrian Antiquities in the British Museum, where he remained until 1933. He returned, however, to Egypt to work at his beloved Tell-el-Amarneh in 1925, and at Armant in 1928, and contributed to the publications on both sites. He held the Laycock Studentship of Egyptology at Worcester College, Oxford, during 1929–35.

At the British Museum, the major outstanding task of the Department was the publication of its demotic papyri. Demotic is a cursive script in which the Egyptians wrote their documents from the seventh century B.C. until the fourth century A.D.; and in 1924 there were comparatively few aids for its study. Inspired by Sir Herbert Thompson, who became his teacher, benefactor and friend, Glanville undertook this task and did pioneer work. His "Catalogue of the Demotic Papyri in the British Museum, Vol. 1: A Theban Archive of the Reign of Ptolemy I Soter" (1939), and Thompson's "A Family Archive from Siut" (1934), set a new standard and method for the publication of demotic contracts. By painstaking compilation of family genealogies and topographical plans of streets and houses, they made the dry legal formulæ yield up a brilliant and intimate picture of the social and family life of Egyptian provincial towns in the Ptolemaic period. Vol. 2 of Glanville's "Catalogue", "The Instructions of 'Onkhsheshonqy" (1956), of which he received the first copy a few weeks before his death, broke fresh ground; in it he deciphered and translated what may well be the last great "Wisdom" book from Egypt. His deep understanding, both of Egypt and of human nature, enabled him often to interpret what might have remained dark to a more cloistered mind; while his firm critical judgment and keen historical sense controlled his imagination and ensured his accuracy.

But Glanville was by no means a one-sided scholar. During his time at the Museum, apart from editing the valuable "Studies presented to F. Ll. Griffith" (1932), he published many articles on the earlier literature and history of Egypt, and acquired a deep knowledge of Egyptian objects, for which he had always had a rare feeling. This became of the utmost importance at University College, London, where he was appointed a reader in 1933, and in 1935 Edwards professor of Egyptology; for his chief task there was the cataloguing of the Petrie Collection. Unfortunately, his work for it was undone by the Second World War. Meanwhile, he edited the "Legacy of Egypt" (Clarendon Press, 1942). During the War he served in the Royal Air Force, in which he reached the rank of wing commander, and was made M.B.E. and received Czechoslovak,

Dutch and Yugoslav decorations. In 1946 he was appropriately appointed to the new chair, founded by his old master, Sir Herbert Thompson, at Cambridge, specifically for demotic and coptic studies, and was elected a professorial Fellow of King's. In the same year he was elected a Fellow of the British Academy, and recently became an honorary Fellow of his own College, Lincoln, Oxford.

At Cambridge, Glanville devoted himself not only to building up the new Department of Egyptology, its library and collections, but also served the University, his College and his Faculty in a host of functions. His courage, clear-sightedness and grasp of principle were always tempered by his warmth, his tact and his humour. Such was the trust and affection in which he was held in his College, that he became in 1954 the first Oxford man ever to be elected Provost of King's College, Cambridge. The loss of his wisdom and friendship there is as grievous as it is to his Department and students. For he was the finest type of teacher; he never spoon-fed, but worked unsparingly and sympathetically to inspire his students to make the best of their own abilities, not in their studies alone, but also in the whole of their life. His life will be an inspiration, his kindness a poignant memory, to his many friends.

H. S. Smith

Prof. Edward Stenz

Edward Stenz, who died after a long illness in Stockholm on February 21 at the early age of fifty-six, had many friends among meteorologists and geophysicists all over the world.

Born in Warsaw, he went to a secondary school there (the Rey Gymnasium); even as a pupil he became an enthusiastic member of the physics section under the leadership of Ziemecki, who after the War took a chair of physics at the Maria Curie-Skłodowska University of Lublin.

Stenz studied in the University of Warsaw under Kowalski, Pieńkowski, Gorczyński, Mazurkiewicz and Sierpiński; he also spent some time at the Jan Kazimierz University of Lwów, working under Arctowski. He took his Dr.Phil. degree at the Stefan Batory University of Wilno.

After graduating, Stenz became a lecturer in the Physics Department of the University of Warsaw, and was afterwards in charge of applied physics at the Technical University of Warsaw; later he was appointed director of the Observatory at Kasprowy Wierch in the Tatra Mountains. He spent the period of the Second World War in Afghanistan, being in charge of the Meteorological Office and professor in the University at Kabul. After the War he went back to Poland and was appointed professor of geophysics in the University of Warsaw. He served as president of the Geophysical Committee of the Polish Academy of Sciences, deputy director of the Institute of Geophysics, and president of the Polish Meteorological and Hydrological Society. He was the author of about ninety papers, covering a wide range of subjects—meteorology, terrestrial magnetism, the Sun and terrestrial radiation and gravimetric measurements; he also published several semi-popular books. All his papers were marked by a clear and attractive style as well as by a high standard of presentation. He was one of the first organizers of the meteorological service for the Polish Air Force.

Stenz was very sensitive, full of stimulating ideas, kindly disposed to others and always ready to give a helping hand to those in trouble. In the summer of 1954 he experienced a great blow: his only daughter fell to her death, while climbing in the Tatra Mountains. His own death means a great loss to Polish science and has deprived all who knew him of one of their most valued friends.

Józef Mazur

NEWS and VIEWS

Kelvin Gold Medal

The Kelvin Gold Medal for 1956 has been awarded to Sir John Cockcroft, director of the Atomic Energy Research Establishment, Harwell. The Medal is awarded every three years to a person of any nationality "as a mark of distinction in engineering work of the kinds with which Lord Kelvin was especially identified", and the administration of the award is in the hands of a committee consisting of the presidents of the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, Naval Architects, Mining and Metallurgy, Mining Engineers, and Engineers and Shipbuilders in Scotland, and the Iron and Steel Institute.

Royal Meteorological Society: Awards

The Royal Meteorological Society has made the following awards: *Buchan Prize*, founded in memory of Alexander Buchan, secretary of the Scottish Meteorological Society during 1861–1907, for the period 1951–55 has been awarded to Mr. F. H. Ludlam (Department of Meteorology, Imperial College of Science and Technology), for his outstanding contributions to the study of cloud physics; *Hugh Robert Mill Medal and Prize* for 1956, founded in memory of Hugh Robert Mill, director of the British Rainfall Organization during 1901–19, has been awarded to Mr. J. S. Sawyer (director of the Forecasting Research Division, Meteorological Office) for his outstanding contributions to the science of meteorology, with particular reference to rainfall.

Linnean Society of London

At the anniversary meeting of the Linnean Society of London held on May 24 the Linnean Gold Medal for 1956 was awarded to Prof. W. H. Lang, emeritus Barker professor of cryptogamic botany in the University of Manchester. The following were elected officers of the Society for the session 1956–57: *President*, Dr. H. Hamshaw Thomas; *Treasurer*, Sir Frederick Stern; *Secretaries*, Dr. H. R. Hewer (zoology) and Dr. C. R. Metcalfe (botany); *New Members of Council*, Mr. D. Etherington, Dr. B. M. Hobby, Dr. Doris M. Kermack, Dr. John Smart and Dr. Errol I. White. Prof. I. W. Bailey, Dr. Anton Brunn, Prof. J. A. Efremov, Prof. Richard Harder, Prof. Bernhard Rensch, Prof. Karl von Frisch and Prof. Ø. Winge were elected foreign members of the Society.

Presidency of the Institute of Fuel: Mr. J. R. Rylands

Mr. J. R. Rylands, who has recently been elected president of the Institute of Fuel and will take office in October next, served his engineering apprenticeship with Henry Berry and Co., Ltd., of Leeds, and then, after service in the Army during the First World War, graduated from the University of Leeds. He worked at first as an electrical engineer with the Taquah and Abosso Gold Mining Co., of the Gold Coast, but later transferred to E. Green and Son, Ltd., of Wakefield, makers of fuel economizers, of which company he is now chief engineer and a director. For his work done with J. R. Jenkinson during the Second World War on fouling problems associated with economizers and air heaters, he received the John Hopkinson Premium for 1943 of the Institution of Electrical Engineers, and this work was followed by further research into the corrosion of boiler, economizer and air-heater surfaces, for which he was awarded the Thomas Lowe Gray Prize for 1948 of the Institution of Mechanical Engineers. Mr. Rylands has been active in the electrical branch of the engineering profession, having served as chairman of the North Midland Centre of the Institution of Electrical Engineers.

J. A. C. Chaptal, Comte de Chanteloup (1756–1832)

The distinguished chemist and statesman, Jean Antoine Claude Chaptal, who was born at Nogaret, Lozère, two hundred years ago on June 4, 1756, is to-day remembered chiefly for his contributions to the technical development of modern industry by the application of the science of chemistry, and for having coined the name for nitrogen. The son of an apothecary, he owed his education to a rich uncle, Dr. Claude Chaptal, and in 1777 he graduated M.D. at the University of Montpellier. After studying science in Paris, in 1781 he was appointed to a specially instituted chair of chemistry at Montpellier, where he taught the new doctrines of Lavoisier with eloquent lucidity. On the death of his uncle he inherited a large fortune, part of which he devoted to establishing chemical works for the manufacture of mineral acids, alum, white lead and soda. In 1797 he was made director of the saltpetre works at Grenelle by the Comité de Salut Public and greatly simplified the procedure of making gunpowder. Two years later he was created a Councillor of State by the First Consul, and in 1801 he succeeded Lucien Bonaparte as Minister of the Interior. In this capacity he founded a society of industries and a vaccine society, reorganized the hospitals, organized schools of pharmacy, introduced the metric system of weights and measures, and did much to promote the scientific culture of vines. Besides his many scientific honours, he was a grand officer of the Legion of Honour (1805), and received the title of Comte de Chanteloup (1811). On Napoleon's return from Elba in 1815 he became director-general of commerce and manufactures. His best-known writings are "Éléments de Chimie" (1790 and several editions), "Traité des Salpêtres et Goudrons" (1796) and "L'Art de faire les Eaux-de-Vie" (1819). He died in Paris on July 30, 1832, at the age of seventy-six.

Joseph Pitton de Tournefort (1656–1708)

Joseph Pitton de Tournefort, who was born at Aix three hundred years ago on June 5, 1656, is remembered as a pioneer botanical systematist whose classification of groups higher than genera was accepted until the time of Linnæus. Born of a noble family, he was intended for the church, but after his father's death in 1677 he devoted himself wholeheartedly to his first love, namely, botany. He studied medicine at Montpellier and also at Paris, where in 1683 he became professor of botany at the Jardin Royal des Plantes. In 1692 he was elected to the Royal Academy of Sciences, Paris, and he received the M.D. of Paris in 1698. Two years later he was sent by the king to Spain, Portugal and Asia Minor to collect botanical material. Reviving the concept of genera and species originated by Kaspar Bauhin, he provided his genera with names and characters, adding the species and varieties without special description. He refused to accept the doctrine of sexuality in the vegetable kingdom formulated by Rudolph Jacob Camerarius, of Tübingen, in 1691–94. Inclined to be dogmatic, de Tournefort regarded the morphology of the flower and fruit as the proper basis for classification, founding his system on the form of the corolla. His most important work was "Eléments de botanique ou méthode pour connaître les plantes" (1694; three volumes with 451 plates). He also compiled a materia medica, which was published in French after his death, an English translation appearing in 1708. A tremendous worker and a vivacious, gay and charming personality, de Tournefort died on November 28, 1708, at the age of fifty-two.

Nature Conservancy

The Committee of Privy Council for Nature Conservation has appointed the following as members of the Nature Conservancy: Lord de Ramsey, Colonel J. C. Wynne Finch, Sir Graham Sutton (director of the Meteorological Office) and Prof. A. R. Clapham (professor of botany in the University of Sheffield). The vacancies have arisen through the death of Sir Arthur Tansley, and the retirement of Prof. R. Alun Roberts, Prof. R. C. McLean and of Mr. C. S. Elton, who remains a member of the Scientific Policy Committee. The following members have been reappointed for a further term of service: Lord Strang, Lord Hurcomb and Dr. E. B. Ford.

Technology as an Educational Discipline

The presidential address to the Institution of Mining and Technology, given on May 17 by Prof. C. W. Dannatt, professor of metallurgy in the Imperial College of Science and Technology, London, was concerned with the study of technology as a branch of education. Discussing how education is acquired, he pointed out that the study of history and the study of science have much in common, following almost identical rules which should engender habits of high moral and intellectual worth: patient and persistent industry; an honest receptivity which accepts substantiated facts even when counter to preconceived beliefs; freedom from prejudice, and a willingness to abandon the most cherished thoughts and theories in the face of evidence; self-reliance and a readiness to challenge statements that seem open to doubt; and clarity of thought combined with constant and painstaking practice in logical inference and deduction. If these qualities become so ingrained in the mind that they are applied in every circumstance of life, the scholar, no matter what his subject of study, will be a cultured man. Accordingly, the failings of the over-specialized

scientist or technologist are due not to the subject of study but to the neglect of matters that should be of interest. Prof. Dannatt claimed that technology when properly used is a satisfactory and efficient implement of culture, but he thinks that we shall eventually be forced to restrict the field of our technologies, and possibly to lengthen the courses so as to maintain standards. He also suggested that we must discard the foolish idea that budding technologists can be identified by examination at the age of eleven or twelve, and that their studies may safely be narrowed and restricted within no more than three or four years. We should also remove the load of specialized studies from the schools and leave them free to perform their task of providing a general basis of education. Technological studies can provide the discipline and basis essential to culture but, like other advanced studies, they need that broader basis of general knowledge which can be developed into vision and understanding.

Technology and the Universities

In his presidential address to the Association of University Teachers on May 25, when he spoke on "Technology and the Universities", Prof. J. L. Montrose, professor of law in The Queen's University, Belfast, submitted a reasoned claim that technology has not merely a place within universities, but is in fact better studied there than elsewhere. He based this claim on the creativeness of application and on the reality of scientific activity in many departments of knowledge. The qualities which constitute the life of reason can be manifested both in the discovery and in the application of knowledge. Moreover, the inclusion of technology within universities can be supported not only by theoretical arguments of the liberating character of thought about problems of the utilization of science but also by descriptive consideration of what happens in such departments—the keen interest in science of their undergraduates and the valuable contribution which the research work of their staffs makes to the understanding of Nature and to scholarship in general. Prof. Montrose summarized the qualities required to ensure that a subject is taught at a university-level with depth and perspective. It is by means of thoroughness that we can attain the broad outlook which sees details of a subject as the application of basic principles, sees principles as seminal ideas growing into the processes by which human problems are treated, and which sees the connexions between one subject and others and the whole of life. Prof. Montrose added that university teachers have not given sufficient thought to the problem of testing intellectual qualities other than the mnemonic. We should endeavour to test not solely powers of recollection and expression but also such other qualities as the ability to discover information about a subject, to apply the principles of a subject to new situations, to comprehend a new and complex statement and to analyse it in relation to criteria for testing its accuracy and, above all, to test inventiveness and imagination. Finally, Prof. Montrose stressed the importance of the quality of staff in our technological institutions and of providing conditions of service that would attract outstanding men and women.

Direction Indicators for Motor-Vehicles

On May 16 the Minister of Transport and Civil Aviation, Mr. H. Watkinson, replying to a question, stated that he has received the final report of the Road Research Laboratory on the comparative merit of the different types of direction indicators now in legal use on motor-vehicles in Britain and that he has reached the conclusion that all three types of direction indicator now permitted should continue to be legal, both to meet the needs of different kinds of vehicles and also as an aid to the export trade. The report is being circulated, and the Minister intends also to circulate to interested organizations proposals for the amendment of the construction and use regulations. These regulations would require direction indicators fitted to vehicles registered after the end of 1958 to be amber in colour, neither to exceed nor fall below certain standards of brightness, and, if of the fore-and-aft flashing type, to be separated from other lights. The Laboratory has concluded that direction indicators should be amber in colour, with an intensity between 100 and 500 candle-power, and that this colour should not be used for other vehicle lights. They are best mounted on the side of a vehicle, roughly at the level of the driver's eye, and should emit light forward and backwards and also appreciably at right angles. No consistent evidence in favour of a flashing rather than a steady light of equal intensity has been found by the Laboratory, and no change in existing practice is recommended, although it is desirable that one type of indicator should be selected for general adoption and alternatives avoided. Uniformity of type of indicator, position, intensity and rate of flash are important, and means for ensuring the observance of standards are desirable.

The Calder Hall Pile

The first of the two atomic piles in the Calder Hall Power Station, which will be the first in the world to supply electricity on a large scale from nuclear sources, has started working. Physical measurements and instrument checks are now taking place, and the gradual commissioning of the plant will follow. H.M. the Queen will perform the official opening of the Station on October 17. For the first time in the history of the world, electricity on a large scale will then be supplied from a nuclear power station to a national electricity network.

Calder Hall is part of the Atomic Energy Authority's programme for power stations and is not included in the national programme, which envisages the construction of twelve atomic power stations by electricity authorities during the next ten years at an estimated cost of £300 million. The Atomic Energy Authority is also building a replica of the first power station on the same site, and another with four reactors at Chapel Cross, Annan, Dumfriesshire. These have the dual purpose of producing electricity and making plutonium for the military programme. Another atomic power station at Dounreay, Caithness, will have an experimental fast breeder reactor capable of creating more fissile material than it burns.

Power from Fusion

The United Kingdom Atomic Energy Authority is holding a one-day symposium on controlled thermonuclear energy on June 4 at Harwell which will be on a classified basis. Invitations have been sent to representatives of industrial research laboratories in addition to government research establishments and British universities. About fifty people have been invited in addition to the Authority's own staff. The object of the symposium, at which a general account of the Authority's own project will be given,

is to encourage fundamental research work along lines which will assist the work of the Authority in this field. Research on the control of the thermonuclear reaction has been going on at Harwell for some time. The conference will be held in private, and no statement will be issued afterwards.

Central Pool of Officers for the Oversea Civil Service

On May 17 the Secretary of State for the Colonies, Mr. A. Lennox-Boyd, made a statement regarding the Oversea Civil Service, further details of which were given in a White Paper published the same day. Mr. Lennox-Boyd said that the Government has decided in principle to establish a central pool of officers with exceptional administrative or professional qualifications who would be employed by the Government in the United Kingdom and be made available as required for secondment to overseas Governments. The central pool will be set up as soon as possible. Meanwhile, to meet an urgent staffing position which has arisen in the territories comprising the Federation of Nigeria, it is proposed, subject to the agreement of the Nigerian Government, to introduce a scheme by which existing expatriate pensionable officers can transfer, on certain conditions, to a special list of the Oversea Civil Service, and officers so admitted will thenceforth be in the service of the Government and seconded to the local Governments. The scheme will be in a form that will permit similar arrangements to be applied to other territories if considered desirable. In reply to questions, Mr. Lennox-Boyd added that officers transferred to the special list will be paid by the employing countries, at rates prescribed by the British Government after consultation with those countries, and that H.M. Government will pay the pensions and recover the money from the Government in whose service the pensions were earned.

Fluoridation of Potable Water in Britain

In view of repeated allegations that the addition of fluoride to public water supplies might have harmful effects, the Minister of Health has again consulted the Medical Research Council. The Council has transmitted to the Minister the advice of a conference of experts, which it called to review the subject, that there is no evidence warranting alteration or abandonment of the fluoridation projects. The experts agreed in general with the conclusions of the United Kingdom Mission (1953) to the effect that, despite considerable interest and research, there is no definite evidence that the continued consumption of fluorides in water at a level of about 1 p.p.m. in drinking water is in any way harmful to health, and they consider that if any untoward effect is revealed by future research this is most unlikely to be serious.

Industrial Welfare Society

In the annual report for 1955, the director of the Industrial Welfare Society, Mr. John Marsh, suggests that side by side with the demands for scientific and technical achievement in industry, there is a great need for men who have personal qualities and who can influence workers at all levels to be self-respecting, co-operative and efficient. Personal qualities are not only needed among those concerned with management but also among the specialists. The technical specialists of industry can create human problems which sometimes offset the efficiency they set out to achieve. For example, the need for work-study engineers is undoubtedly great; but industry must select men for training in these tasks who are fundamentally sound in their knowledge and understanding of their fellow men. They must certainly know something about the effect of changes in skill on a man's reason and emotions. Among other items referred to by Mr. Marsh are the lack of clearly defined promotion systems in the majority of industrial concerns and the amazing dearth of suitable reading matter for the large number of supervisors and apprentices in industry.

A Bibliography of Plant Protection

Under this title a comprehensive work covering the year 1951 has been issued in German, English and French by the Biologische Bundersanstalt für Land- und Forstwirtschaft in Berlin-Dahlem, under the editorship of Dr. J. Bärner (pp. xliv + 420; Paul Parey, Berlin and Hamburg, 1955). This bibliography, which comprises more than 12,500 titles, is in continuity with the original publication on this subject begun in 1921 and already including twenty-two volumes covering the years 1914–45. The volumes covering the years 1946–50 are to follow in the near future. The original layout has been maintained and includes a general section dealing with collective works, text-books, reports of congresses, bibliographies, etc., followed by other sections on diseases and their causes, diseases and host plants, measures of plant protection and an index of authors.

University of Leeds: Appointments

Dr. C. E. Lumsden, of the Institute of Neurology, London, has been appointed professor of pathology and head of the Department of Pathology in the University of Leeds. The following have been appointed lecturers in the University: Dr. R. O. Gandy (applied mathematics), R. J. R. Hayward (Brotherton lecturer in inorganic and structural chemistry), Dr. G. R. Higginson (mechanical engineering), M. A. Jeeves (psychology), Dr. L. Mackinnon (physics), P. Sutcliffe (civil engineering) and W. H. Trickett (statistics).

University of London: Appointments

Mr. J. D. Evans, Research Fellow at Pembroke College, Cambridge, has been appointed to the University of London chair of prehistoric European archæology, tenable at the Institute of Archæology, and Dr. J. H. Birkinshaw, reader in biochemistry at the London School of Hygiene and Tropical Medicine, has been appointed to the University of London chair of biochemistry, tenable at that School. The following have been appointed to University readerships tenable at the Colleges indicated: P. T. Fink (Imperial College of Science and Technology), aeronautics; Dr. G. P. Wibberley (Wye College), agriculture with special reference to agricultural economics; and Dr. W. L. Wilcock (Imperial College of Science and Technology), instrument technology.

University of Sheffield

In the University of Sheffield the Refractories Section of the Department of Metallurgy has been created a separate Department of Refractories Technology with Prof. J. White as its head. The title of reader in electrical machinery in the University has been conferred on O. I. Butler, senior lecturer in electrical engineering. Dr. G. B. Greenough, senior lecturer in physical metallurgy, has resigned from the University on appointment as research

manager, Atomic Energy Authority (Industrial Group), Windscale, Cumberland.

Announcements

Dr. Lee A. DuBridge, president of the California Institute of Technology, has been elected a member of the Board of Trustees of the Rockefeller Foundation, New York.

Mr. T. D. Whittet, chief pharmacist at University College Hospital London, has been elected a foreign member of the Royal Spanish Academy of Pharmacy, founded in 1589 as the Brotherhood of the Apothecaries of Madrid and one of the oldest pharmaceutical organizations in Europe.

Replying to questions in the House of Commons on May 15, the Parliamentary Secretary to the Ministry of Works, Mr. J. R. Bevins, said that the research associations as a whole spend about one-quarter of their budgets, or more than £1 million a year, on development. Several development companies have been formed by the research associations, and the Government is also starting some civil development contracts with scientific research associations.

The Challenger Society is prepared to make small grants for research in marine biology or oceanography at a recognized laboratory during the year June 1956–June 1957. Applications, accompanied by details of the proposed research, should reach the Honorary Secretary, Challenger Society, British Museum (Natural History), London, S.W.7, before June 11.

A symposium on "Rheological Research in the Textile Industry", arranged by the British Society of Rheology, will be held at the British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester 22, during June 7–8. Further information can be obtained from Dr. A. S. Lodge at the Association.

The summer conference and annual meeting of the Society for Applied Bacteriology will be held in Reading on July 16–18. In addition to the usual programme, there will be a whole-day excursion to the Microbiological Research Department of the Ministry of Supply at Porton. Further information can be obtained from the honorary secretary, G. Sykes, Boots Pure Drug Co., Ltd., Microbiology Division, Standards Department, Nottingham.

The eleventh annual physics congress of the Canadian Association of Physicists will be held in the University of Montreal during June 14–16. Included in the programme will be three symposia on the following topics: high-energy physics and accelerators; geophysics; and the teaching of high-school physics. Further information can be obtained from the Association, c/o the Department of Physics, McMaster University, Hamilton, Ontario.

The Royal Institute of Chemistry has arranged a symposium on "Recent Advances in the Chemistry and Industrial Applications of Cereals", to be held in the University of St. Andrews during June 25–29. The three sessions will be concerned with the following topics: production of cereals; processing and testing of grain and grain products; and applications of cereals. Application forms and further information can be obtained from the Secretary of the Institute, 30 Russell Square, London, W.C.1.

An international conference on "Chemical Engineering in the Coal Industry", sponsored by the National Coal Board, will be held during June 26–29 in the new laboratories of the Board's Coal Research Establishment at Stoke Orchard, near Cheltenham, Gloucestershire. The conference will comprise four technical sessions: physical and chemical pretreatment of coal; fluid bed carbonization; briquette carbonization; and liquid by-products. Seven papers given by British, French, German, Dutch and American workers will be read and discussed. English, French and German will be the working languages. Attendance will be by invitation only.

An international congress on automation, organized by the Department of Mechanics of the Conservatoire National des Arts et Métiers, Ministry of Public Education, will be held in Paris at the Conservatoire National during June 18–24. The aims of the congress are to consider certain aspects of general automation and its application to various scientific, technical, economic and psychological fields. It will be divided into three sections: general automation; applied automation; and automation and production. Further information can be obtained from the Secrétariat du Congrès International de l'Automatique, Chaire de Mécanique, C.N.A.M., 292 rue Saint-Martin, Paris 3e.

Under the auspices of the International Institute of Embryology a congress on developmental biology will be held in the United States at Brown University during July 23–26, and will be followed by a conference on cytodifferentiation during July 27–31, sponsored by the International Union of Biological Sciences. Applications for both meetings should be sent as soon as possible to Prof. J. Walter Wilson, Department of Biology, Brown University, Providence 12, Rhode Island. Correspondence about the meetings should be sent to G. A. Norton, Developmental Biology Conference Series 1956, National Academy of Sciences, National Research Council, Division of Biology, 2101 Constitution Avenue, Washington 25, D.C.

The fourth of the annual courses arranged by the Italian Physical Society at the Villa Monastero, Varenna, Lake Como, will be held this year during July 15–August 4 and will be on the magnetic properties of matter. The course will be in English and French, and lectures will be given by the following: C. J. Gorter (Kamerlingh Onnes Laboratory, Leyden), C. Kittel (University of California, Berkeley), N. Kurti (Clarendon Laboratory, Oxford), L. Néel (Laboratoire d'Électrostatique et de Physique du Métal, Grenoble), M. H. L. Pryce (H. H. Wills Physical Laboratory, Bristol), E. M. Purcell (Harvard University), and J. H. Van Vleck (Harvard University). The fee for the course is 30,000 lire (or 25,000 lire for shared accommodation). Applications should be sent at once to the director of the course, Prof. L. Giulotto, Istituto di Fisica dell'Università, Pavia.

Erratum. In the article entitled Colonial Research in the British Commonwealth in *Nature* of March 3, on p. 418, reference was made to the work at the Freshwater Field Station at Birnin Kebbi, in Northern Nigeria; it was incorrectly stated that a study of marine invertebrate fauna was in progress. This work is being carried out at Freetown, Sierra Leone. Birnin Kebbi, on the River Sokoto, deals with freshwater investigations, mainly on the fish in the area.

SYMPOSIUM ON THE NEUROHYPOPHYSIS

AN international symposium on the neurohypophysis, arranged by the Colston Research Society and the University of Bristol, was held in Bristol during April 9–12. A generous grant from the Wellcome Trust made it possible to extend invitations to workers from the United States and Canada. Prof. H. Heller (Bristol), director of the symposium, welcomed the participants and pointed out that this was the first international meeting entirely devoted to the subject. He reminded his audience that it was also a scientific anniversary, since it was fifty years ago that Sir Henry Dale had discovered the oxytocic effect of posterior pituitary extracts.

Sir Henry Dale then opened the symposium. In a fascinating survey of the history of the subject, he recalled that the first evidence for the presence of a biologically active principle in the pituitary gland was obtained by G. Oliver, a Harrogate physician who, having observed the pressor effect of adrenal extract, proceeded in collaboration with E. A. Schäfer to test extracts of other endocrine glands on the blood pressure of anæsthetized animals. Sir Henry then mentioned his early experiments on the chemistry of the posterior pituitary principles, which already then—in 1909—suggested that they were peptides, and described the first separation of oxytocin from vasopressin by H. W. Dudley in his laboratory, work which found its brilliant conclusion only recently in the establishment of the chemical constitution of the active peptides by V. du Vigneaud and his co-workers. Similarly, the old difficulty of understanding how an organ consisting of neuroglia and nerve fibres could produce hormones has only recently been overcome by including the neurosecretory cells in the hypothalamus in the neurohypophysial system. Based on these developments and on recent unpublished work by Dr. Catherine Hebb, Sir Henry drew an interesting parallel between the results of pituitary stalk section and the cutting of a cholinergic nerve: in both cases the active principle(s) disappears rapidly distal to the cut and accumulates proximally.

The rest of the session was devoted to the morphological aspect of neurohypophysial secretion. Prof. W. Bargmann (Kiel), reviewing the relation between neurohypophysial structure and function, stressed the parallelism between the demonstrable amounts of neurosecretory material in the neurohypophysis and its hormone content in a variety of physiological and experimental conditions. He discussed the site of origin of the neurohypophysial hormones and mentioned the unpublished finding of W. Hild that pituicytes in tissue culture are unable to elaborate the hormones. These cells may, however, be concerned in their release. In conclusion, Prof. Bargmann directed attention to the fact that neurosecretory fibres also enter the pars tuberalis and pars intermedia. In the discussion, Prof. B. Hanström (Lund) mentioned the rarity of such fibres in the pars intermedia of some mammalian forms, a finding with which Prof. Bargmann agreed. Dr. H. Rodeck (Düsseldorf) gave new evidence for the lack of neurosecretory material in new-born animals and in infants, and Profs. C. Fromageot (Paris) and H. B. van Dyke (New York) agreed that no firm statement can as yet be made as to the chemical nature of the neurosecretory substance.

Prof. Hanström, in a comprehensive and stimulating survey, showed the close similarity in the architecture of the neurosecretory systems of invertebrates and vertebrates. Crustaceans and insects, for example, have not only neurosecretory cells in their brains but also specific storage organs for the neurosecretory material elaborated. In the discussion, Dr. P. A. Jewell (London) described the histological appearance of the neurohypophysis of dogs which have been continuously hydrated for ten days.

The day concluded by the annual reception of the Colston Research Society in the Great Hall of the University, at which the Lord Mayor, the Vice-Chancellor of the University and the immediate past-president of the Colston Research Society, the Bishop of Bristol, were present. The president of the Society, Prof. Macgregor Skene, explained the origin and purpose of the Colston Research Society, and Sir Lionel Whitby, the guest speaker, gave a masterly address on the importance of endocrinology in clinical medicine.

The second day of the symposium was opened with a paper by Prof. C. Fromageot (Paris). He and Dr. R. Acher have investigated the active protein which can be obtained from ox pituitary glands and have found that its pressor and oxytocic activities behave towards chemical and enzymatic agents exactly like the pure polypeptides. Mild processes like counter-current distribution and electrodialysis, which do not involve hydrolysis, dissociate the active protein into substances responsible for the oxytocic and pressor activities and at least one inert protein. This suggested the possibility of a differential release of the hormones *in vivo*. Prof. Fromageot adduced evidence for such difference in hormone release in lactating rats. Prof. H. Croxatto (Santiago, Chile) analysed the chemical and biological properties of polypeptides with posterior pituitary-like activities which can be obtained by the action of enzymes on blood proteins. Though similar in many ways, these artificial peptides differ in some respects from vasopressin and oxytocin. The paper gave rise to discussion on, among other topics, Prof. Croxatto's suggestion that his peptides may be connected with the 'unspecific' antidiuretic and oxytocic effects so frequently encountered in tests with biological material. The third paper of the morning was read by Prof. H. B. van Dyke (New York), who, with characteristic thoroughness and lucidity, reported on problems concerned with the storage and liberation of the neurohypophysial hormones. The relative distribution in the hypothalamic nuclei and the neural lobe differs from species to species; the dog's hypothalamus, for example, is much richer in vasopressin, whereas camel tissue contains more oxytocin. Depletion of hormones stored in the posterior lobe, if severe, affects both hormones, although the teleological requirement may be only for one. In lactating dogs both principles are depleted from the neural lobe, but the depletion of oxytocin is greater. Prof. van Dyke then adduced most interesting new evidence on two forms of vasopressin occurring in mammalian glands. Only hog extracts contain lysine vasopressin; all other mammalian extracts tested

(including those of human glands) seem to contain arginine vasopressin, which has a relatively higher antidiuretic potency than hog vasopressin. In the discussion, Dr. S. J. Folley (Reading) and Prof. G. W. Harris (London) pointed out that differences in hormone ratios found during lactation in different species may be related to different suckling habits.

The afternoon session, under the chairmanship of Prof. J. M. Yoffey (Bristol), was occupied by papers on the metabolism and fate of the neurohypophysial principle. Prof. H. Heller (Bristol) surveyed the subject and queried the applicability of many *in vitro* experiments with body fluids and tissues. Recent results obtained in his laboratory (in collaboration with Dr. S. M. A. Zaidi, of Lahore) show that the kidneys and liver in the intact rat inactivate exogenous and endogenous vasopressin with very great rapidity. In the discussion, Dr. F. Gross (Basle) quoted supporting evidence, and Prof. Fromageot explained that there are three different chemical reactions conceivable by which vasopressin can be quickly inactivated. Prof. R. L. Noble (London, Ontario), in his paper on the excretion of posterior pituitary principles in the urine, described a new method for the extraction of vasopressin from body fluids which allows a consistent recovery of 85–90 per cent of added hormone. He then reported on the occurrence of antidiuretic activity in human urine in conditions like dehydration, fainting, emotional upsets and electro-convulsive therapy.

The third day of the symposium began with a paper by Dr. M. Ginsburg (Bristol), who described experiments which suggest that vasopressin may play a part in maintaining the blood pressure after hæmorrhage. Discussing a variety of stimuli to the neurohypophysis, he emphasized that stimuli for the release of hormones must be distinguished from those which lead to an increase of production of the active principles. He then described experiments in collaboration with Mrs. L. Brown, in which by means of injections of hypertonic solutions into the internal carotid they have unsuccessfully attempted to produce antidiuretic effects in the rat, and enumerated factors which might have prevented such responses. This led to a long discussion on the efficacy of osmotic stimuli to the neurohypophysis, in which Drs. P. A. Jewell (London), M. Pickford (Edinburgh), D. F. Cole (Newcastle), H. E. de Wardener (London), J. C. Sloper (London), H. Croxatto (Santiago) and F. Morel (Paris) participated.

A paper read by Dr. B. Andersson (Stockholm) extended the field of the symposium in a most interesting manner by showing that electrical stimulation of certain areas of the hypothalamus by the elegant 'indirect' method developed by G. W. Harris, or by direct injection of hypertonic sodium chloride solution, induces polydipsia in the goat. This 'drinking area' overlaps partially with that from which antidiuresis can be elicited. This raises the interesting possibility of a dual role of the hypothalamic osmoreceptors in regulating both water intake and water output. Dr. B. A. Cross (Cambridge) pointed out that he has found in the rabbit that stimulation of the paraventricular nucleus results in the release of oxytocin, but that Dr. Andersson has shown for the first time that antidiuretic hormone also can be released by stimulating the same hypothalamic area. Dr. Mary Pickford (Edinburgh), in a paper with Dr. F. B. Brooks (Philadelphia), described experiments which make it possible that oxytocin, by influencing electrolyte excretion, has a physiological action on the kidney. This possibility had been envisaged in the rat by Dicker and Heller and Heller and Stephenson; but Pickford and Brooks have now shown that in certain circumstances oxytocin modifies renal sodium and potassium excretion in the dog also.

The afternoon session was devoted to papers on the mechanism of action of the antidiuretic hormone. Prof. H. Wirz (Basle), by accomplishing the astonishing feat of puncturing single distal tubules of the concentrating or diluting rat kidney and analysing the fluid obtained, has been able to support the concepts of H. W. Smith on the site of action of the antidiuretic hormone in the renal tubule. He agreed with Dr. W. H. Sawyer (New York), the following speaker, in postulating that the essential action of the hormone consists in altering the permeability of a section or of sections of the distal tubular epithelium to water. Both speakers also agreed in the revolutionary assumption that the antidiuretic hormone is not directly concerned in the elaboration of hypertonic urine. Equally interesting was Dr. Sawyer's suggestion that the increase in tubular water absorption, which he has found to be caused in frogs by neurohypophysial extracts, is based on the same mechanism as their action on the frog's skin.

The first paper on the last day of the symposium was by Drs. S. J. Folley and A. T. Cowie (Reading), who gave an admirable survey of the relations of the neurohypophysial hormones to the mammary gland. The interesting concept was mentioned that the release of the lactogenic and galactopoietic factors from the anterior lobe may be controlled by oxytocin, thus uniting the main phases of lactation – milk secretion and milk ejection. Experiments by Folley and Benson relevant to this hypothesis are giving encouraging results. A vivid discussion, in which the chairman of the session, Sir Solly Zuckerman (Birmingham), Prof. G. W. Harris and Drs. M. Pickford, F. Stutinsky (Paris), I. Chester Jones (Liverpool) and J. C. Sloper took part, developed on the question of the reorganization of the cut pituitary stalk. A paper by R. J. Fitzpatrick (Bristol) on the relation of oxytocin to uterine function followed. He showed that different parts of the uterus vary quantitatively in their response to oxytocin. This was interpreted in relation to the requirements for sperm transport and the expulsion of the fœtus at term. The third speaker of the morning, Dr. J. M. Walker (Oxford), described experiments with G. W. Bisset in which, utilizing a method for the extraction of oxytocin and vasopressin from blood, they have investigated the release of the hormone under the influence of drugs. He made the important point that pharmacologically the hypophysial synapse differs from that in peripheral ganglia.

The last session dealt with adrenocortical–neurohypophysial relationships. Dr. R. Gaunt (Summit, N.J.), after a critical review of the problems involved, reported on new work with C. W. Lloyd and J. J. Chart. Their most interesting finding perhaps is that hydrocortisone-like steroids either inhibit the release or facilitate the synthesis of vasopressin and of neurosecretory material.

Dr. I. Chester Jones (Liverpool) continued to unravel the relationship between the neurohypophysis and the adrenals by describing the morphological and functional changes in adrenalectomized rats with diabetes insipidus. Dr. F. Stutinsky then compared the effect of the ingestion of hypertonic salt solutions on the adrenal cortex of normal rats

and animals with diabetes insipidus, and Dr. Lucie Arvy (Paris) showed slides which gave the first suggestion that the neurohypophysis is implicated in the osmoregulation of teleost fishes.

The pleasant atmosphere and the apparently general enjoyment in the symposium can be attributed not only to the restricted number of participants (nearly all of whom were actively engaged in research on its subject) but also to the excellent arrangements of the Colston Research Society, which housed all members in Manor Hall, a hall of residence of the University of Bristol. The scientific meetings were held in the same building, so that much unnecessary inconvenience and loss of time were avoided. The proceedings of the symposium will be published as Volume 8 of the "Colston Papers". H. HELLER

EUROPEAN SEISMOLOGICAL COMMISSION

MEETINGS IN VIENNA

THE European Seismological Commission, a Commission set up by the Section for Seismology and the Physics of the Interior of the Earth of the International Union of Geodesy and Geophysics, met in the Institute of Physics of the University of Vienna during April 4–7 under the presidency of Prof. W. Hiller, of Stuttgart. The Commission had the support of Unesco, and nineteen countries were represented. Four topics were discussed: the organization and preparation for carrying out large explosions, particularly in Alpine regions, for seismic purposes; the progress achieved in the preparation of a European Earthquake Catalogue and a seismotectonic map of Europe; the progress made in the design and construction of seismographs, particularly those to be used to record near earthquakes, and the testing of such instruments; and microseisms.

The methods of seismic prospecting for minerals (particularly for possible oil-bearing structures) by letting off small quantities of explosives and receiving the reflected and refracted sound waves on geophones or seismographs are by now well known, and the subject has an extensive literature of its own. It was by this means that the British oilfield at Eakring was discovered. Only one explosion in Great Britain has been large enough to send waves down to penetrate all the layers of the Earth's crust, and this explosion was accidental—namely, the Burton-on-Trent explosion of November 27, 1944. In 1909 A. Mohorovičić found a discontinuity at the base of the continental layers of the Earth's crust in south-east Europe at a depth of 60 km., now called the Mohorovičić discontinuity. Its depth varies over the Earth, but it is almost always present; in France it is estimated to be at a depth of 38 km., and under the Central Appalachians in the United States it is 40–50 km. The possible variation of the depth of the Mohorovičić discontinuity under mountain regions such as the Alps in Europe is particularly interesting, and it is proposed to try to find such depths by using the methods of seismic prospecting with sufficient quantities of explosives so that the *P*-waves which are generated will penetrate below the discontinuity. The time and place of the explosion, being known, will give fewer unknowns in the calculations than with natural earthquakes, and the arrival times of the reflected and refracted waves, being approximately known, will render possible the use of faster than normal paper speeds in the seismographs and thus greater accuracy in the time measurement. Moreover, since the explosion point is known, it will be possible to arrange the positions of the seismographs to advantage both in azimuth and distance.

The first experiments in western Europe will be carried out by the French during the second half of August 1956 at Briançon. The first explosions will be set off in the middle of a lake which is situated at a height of 2,500 m. above sea-level, and there will be five successive explosions of 1, 2, 2, 5 and 10 tonnes. The first ones will give experience of the best methods, and the whole series will give an idea of the optimum or minimum quantity of explosive necessary for the purpose. The French will set up seismographs situated along two lines which will intersect at right angles at the lake. The explosions will also be recorded by seismographs in Germany, Italy and perhaps in Czechoslovakia. As soon as the results of this work have been studied, the French seismologists propose to make a further series of similar experiments from a lake situated 40–50 km. to the east of the first one, so that records may be obtained over the same ground but in the reverse direction. This is so that true wave velocities may be determined in the manner usual in seismic prospecting. The second series of explosions will probably be held in 1957. As soon as the results of the first French experiments are known, similar explosion experiments will be made in the Eastern Alps, probably in the Hohe Tauern, east of Innsbruck in Austria, but these will not be possible this year.

Experiments in the U.S.S.R. along these lines have already taken place, organized by the Geophysical Institute of the U.S.S.R. Academy of Sciences under Academician G. A. Gamburtzev, the results being communicated to the Vienna meeting by Prof. E. F. Savarensky. The method used by the Russians is called the *GSZ* method and makes use of explosions of 50–300 kgm. of material. The distance between the explosion point and reception point may be up to 400 km. The charges are usually placed in reservoirs, lakes or rivers and are exploded during meteorologically quiet times at night. The effective sensitivity of the reception devices is increased by properly regulated frequency ranges with a maximum amplification, by the increase of the general sensitivity of the equipment under a low level of internal noise and by use of methods of bunching reception. The registration of waves, including radiation of wavelength shorter than usually recorded hitherto, is effected by the use of many-channel stations which permits the most effective correlation methods. Receptors are arranged in different azimuths, and note is taken of the polarization of the oscillations. Different types of waves are distinguished (longitudinal, transverse and surface), as are also differences between single waves and waves resulting from complex interference. Separate crossings of profiles and also groups of reception points are used, the shot point being static.

In particular, large explosions have been made by these methods and for these purposes at Korkino near Chelyabinsk in the Ural Mountains, at Tula in the European part of the U.S.S.R. and in Central Asia. The *GSZ* method was used in pre-mountain and mountain regions of North Tien-Shan, in Western Turkmenia, in Pamiro-Altaisk and other regions. The section from south to north through the mountain ridges of the Kungey-Ala-Tau and Jan Karsky-

Ala-Tau shows two roots going deep into the Mohorovičić discontinuity. The granitic layer shows no roots, but the Mohorovičić discontinuity repeats, with some distortions and with greater amplitudes, the surface relief. It is noteworthy that the foci of all natural earthquakes in the district originate near the basaltic layer, and that the large negative gravity anomaly (up to 250 mgl.) in the district depends mainly on the form of the Mohorovičić discontinuity and not on the granitic layer. The *GSZ* method of deep seismic sounding has thus been used in the U.S.S.R. to study the peculiarities of relief of the internal crustal layers of the Earth (sedimentary, granitic, basaltic), especially in mountain regions; to study these surfaces near deep geological faults; and to give a quantitative physical explanation of the peculiarities of the regional gravitational field. At the Vienna meeting E. Tillotson described the work of Dr. M. N. Hill, of Cambridge, and his co-workers, who use explosions at sea in order to determine the structure of the sea bed. In this method use is made of sono-radio buoys. Prof. H. Menzel and his colleagues at Hamburg intend to follow this method in order to elucidate the very interesting geological structures between Germany and Denmark on one hand, and Norway and Sweden on the other.

Reports from countries represented at the meeting, and also twelve papers, were read concerning the proposed seismo-tectonic map of Europe and the making of the European Earthquake Catalogue. This project is now locally well advanced, and the collection and correlation of the data were placed in the hands of Dr. M. Båth, of Upsala, with the assistance of six colleagues strategically placed in Europe. It is intended, when the map has been completed, to shade it to show the different degrees of seismicity.

Six papers were read at the Vienna meeting, and a good deal of discussion took place, concerning short-period seismographs for the registration of near earthquakes. One paper, presented by Prof. W. Hiller, concerned the new short-period seismographs with magnetic amplification for recording on smoked paper, the prototypes of which have been set up in Stuttgart. The European Seismological Commission recommended the standardization of the constants of short-period electromagnetic seismographs so far as local circumstances permit. Each instrument should have a period (T_m) of the movement of the ground corresponding to a maximum sensitivity between 0·6 and 1·0 sec., and damping coefficients α and β of the pendulum and galvanometer for the seismograph without equivalent reaction, greater than or equal to 0·6. It was left to a small committee under Prof. F. Gassman, of Zurich, to investigate the best methods of testing short-period instruments by shaking-table experiments.

Three papers on microseisms were read, and the Commission passed a resolution requesting the Seismological Commission of the International Geophysical Year to give as soon as possible all the necessary directives for making as complete an investigation as possible of microseismic activity during the International Geophysical Year. Prof. K. E. Bullen, of Sydney, president of the Section of Seismology and the Physics of the Earth's Interior, then gave a lecture on his present tentative views concerning the structure of the Earth with its mantle, core and inner core, and the structure of some of the planets.

Additional members of the European Seismological Commission were then agreed upon from Czechoslovakia, Lebanon, Poland, Rumania, Switzerland (in place of Dr. Wanner, deceased) and the U.S.S.R. Officers elected were: *President*, Prof. P. Caloi (Rome); *Vice-President*, Prof. W. Hiller (Stuttgart); and *Secretary*, Elie Peterschmitt (Strasbourg). The next meeting of the Commission will be held in Utrecht during Whitsuntide 1958.

Ernest Tillotson

RADIO-FREQUENCY PHYSICS

CONFERENCE IN GENEVA

THE 'Colloque A.M.P.E.R.E.' (Atomes et Molécules par Études Radio-Electriques) is an organization inspired by Prof. R. Freymann, of the University of Rennes, which was set up soon after the end of the Second World War as a means of ensuring fruitful contact between French research workers interested in any branch of physics that is concerned with the use of radio frequencies (including the microwave region). It was also part of an effort to re-establish scientific research in France, which had suffered very heavily in the War and was quite unfamiliar with the great advances made during the years of hostilities. The subjects at the annual conferences include dielectric constant and loss, magnetic permeability and loss, nuclear magnetic resonance, quadrupole magnetic resonance, paramagnetic resonance, ferromagnetic resonance and associated effects, and microwave spectroscopy. Although primarily a French organization, interest in it has become more general, and it would now be better described as European, although, of course, any scientist is welcome. It has been a matter of considerable pride and satisfaction to the French-speaking members that all the conferences have employed French as the principal language. I feel that this—and the colloquium itself—has helped to give the French renewed confidence and has contributed in some measure to the present renaissance of scientific research in France. It has also made many English-speaking persons appreciate the difficulties which the prevalent use of English at scientific conferences poses for many scientists.

A pattern is being established in which the annual conference is held alternately in France and elsewhere in Europe. This year's conference was held during March 21–23 in the Institute of Physics of the University of Geneva and was attended by some hundred and fifty scientific workers. That for 1957 will be held in St. Malo, Brittany, and will be organized by Prof. R. Freymann.

A special effort was made to widen the appeal of the conference this year in view of the fact that it marks the tenth anniversary of the discovery of nuclear magnetic resonance absorption. General lectures outlining the history and present situation in nuclear magnetic resonance were given by Prof. C. J. Gorter (Leyden), "Vingt années de recherches aux Pays-Bas sur les résonances magnétiques"; Prof. M. Grivet (Paris), "Exposé sur les travaux effectués par l'équipe française de résonance nucléaire"; Prof. L. Giulotto (Pavia), "Exposé sur les travaux récents effectués au Laboratoire de Pavie dans le domaine des temps de relaxation nucléaire"; Prof. R. A. Ogg (Stanford), "Application à la chimie

de la résonance magnétique nucléaire"; and Prof. A. Lösche (Leipzig), "Quelques travaux sur la résonance paramagnétique nucléaire effectués à Leipzig". A lecture by Prof. C. H. Townes (Columbia) on the measurement of time by spectroscopic methods was an apt illustration of the application of many of the ideas and techniques discussed during the conference.

Some fifty papers were presented in six sessions, fairly evenly distributed over the subjects mentioned above and representing contributions from some thirty laboratories. Preprints of almost all the papers were available before the conference; authors were allowed fifteen minutes for presentation of the gist of their papers, and the matter was then thrown open to discussion. As is usual at these conferences the discussions were unusually free and frank and therefore most valuable to all concerned. It is perhaps conducive to a free exchange of views at such a meeting that the discussion itself is not recorded or published.

It is evidently impossible to mention each paper in detail, and I am obliged to pick out the ones which seemed of more than usual interest. The first two sessions on dielectric constant and loss included several papers on measuring techniques. There were also two papers on mixtures, which still present many difficulties, by J. M. Hough and J. A. Reynolds (Hull) and by G. P. de Loor (The Hague). Study of the dielectric properties of hydrogen-bonded liquids (R. Arnoult *et al.* (Lille) and C. Brot (Paris)) continues to produce interesting results. G. Offergeld (Brussels) described dielectric measurements on a series of methacrylate polymers. R. Freymann and his group (Rennes) presented papers on dielectric effects in various solids and particularly in selenium and zinc sulphide, showing the effect on dielectric properties of illumination at 3650 A. They also showed that one of the dielectric absorption regions in solid camphor is in reality due to fenchone impurity.

The third session, on electron resonance of various types, included several papers on free radicals and particularly on DPPH. R. Gabillard (Geneva) and J. Berlande (Paris) described ingenious uses of electron resonance in the control and measurement of magnetic fields in particle accelerators. Measurements on ferrites still attract considerable interest in view of their great technical importance; several papers in the fourth session were concerned with these and in particular with the Faraday effect (F. Mayer, of Grenoble), the behaviour in the resonance region (J. Pauleve, of Grenoble), and the effect of losses (J. Snieder, of The Hague). In the fifth session, J. Winter and J. Brossel (Paris) described electron resonance experiments on optically oriented sodium atoms in which they observed absorption bands at multiples of the usual Larmor frequency. D. Dautreppe and B. Dreyfus (Grenoble) discussed the effect of hydrostatic pressure on the pure quadrupole resonance frequency in *p*-dichlorobenzene; the effect found is readily interpreted in terms of the effect of the pressure on the libration frequency of the molecule in the lattice.

In the last session G. E. G. Hardeman and N. J. Poulis (Leyden) presented new results on the relaxation time for proton magnetic resonance in the antiferromagnetic crystal, hydrated copper chloride, and showed that the relaxation is due to interaction with the copper ions. W. G. Proctor (Basle) described experiments in which the nuclear resonance signal of sodium in sodium chloride is modified by subjecting the sample to ultrasonic radiation at double the Larmor frequency. J. G. Powles (London) discussed the correlation between mechanical, dielectric and nuclear resonance absorption processes in polymers. G. J. Béné, R. Beeler and D. Roux (Geneva) showed that paramagnetic resonance can now be used to measure magnetic field strength down to about 0·05 oersted using metal–ammonia solutions, which have very narrow lines. H. H. Staub (Zurich) has measured the nuclear relaxation time for the rare gas xenon and found a satisfactory explanation in terms of nuclear quadrupole interactions during interatomic collisions.

The success of the conference was due in large measure to the excellent organization of Prof. Extermann, Dr. Béné, Dr. Denis and Miss P. Cottier. A report of the conference is being published in the May issue of the *Archives des Sciences*, and copies can be obtained from the Institut de Physique, Université de Genève, price 25 Swiss francs.

J. G. Powles

PELAGIC MOLLUSCA: SWIMMERS AND DRIFTERS

THE Malacological Society of London held an open discussion meeting in the rooms of the Linnean Society on the evening of March 14, with Prof. Alastair Graham (University of Reading) in the chair. Invitations had been issued to the staff and students of biological departments, and there was a large attendance, mainly from scientific institutions in or near London, and also from Reading, Oxford and Swansea.

Dr. J. E. Morton (Queen Mary College, London) introduced the subject of pelagic Mollusca with an account of pelagic prosobranchs. Prosobranchs became pelagic in two instances, both of them in the order Mesogastropoda. The three families, together known as the Heteropoda (Atlantidae, Carinariidae and Pterotracheidae), are actively swimming carnivores, and the family Ianthinidae are passive drifters. These two groups illustrate strongly contrasting modes of attaining the pelagic life. In the Heteropoda, the emphasis was upon the lightening and eventual loss of the now unnecessary shell, and the development of lightness and buoyancy, with the tissues becoming jelly-like and the heavy viscera restricted to an insignificant mass. The mantle cavity was fully retained in *Atlanta* and eventually lost in *Pterotrachea*. The foot was transformed into a gracefully undulating fin, and there was considerable speed of movement. Large eyes were developed, with great visual acuity. The shape of the body became fusiform, the higher families losing the planorboid spiral form of *Atlanta*. They are reminiscent of small translucent serpents, moving rapidly, and with the sharp teeth of the buccal mass taking a strong hold of smaller planktonic prey.

The Ianthinidae adopted a pelagic life in a very different way from the Heteropoda. The shell—though lightened—remains of normal size, and forms a globular body whorl with a short apex, vivid violet in colour, floating mouth uppermost. The animal has no special locomotor organs and drifts at the surface, buoyancy being conferred not by jelly-like tissues but by a raft secreted by the foot. In *Ianthina ianthina* this consists of a bubbled mass of air-filled

vesicles; in *I. prolongata* and *I. exigua* it is flatter and is used also for the attachment of egg capsules to its under-surface. The teeth of the radula are long and sharp. *Ianthina* feeds on the floating siphonophore *Velella*, attaching itself to the under-surface of the siphonophore and grazing upon its living tissues, until the chitinous float is stripped bare. When feeding on *Velella*, *Ianthina* appears to lose the raft and to make use of the siphonophore not only as food but also to obtain buoyancy and transport. This specialized mode of feeding suggests an origin for the Ianthinidae among those benthic mesogastropods which are sluggish carnivores, grazing on sessile animals, including cœlenterates. *Ianthina* illustrates such a mode of feeding transferred to the pelagic level.

Dr. J. E. Forrest (Queen Mary College, London) directed attention to the interest and importance of the order Opisthobranchiata in considering the development of the free-swimming habit in the Mollusca. The order includes benthic as well as truly pelagic species, while some, essentially creepers, are yet able to adopt a swimming habit at times. It is, therefore, perhaps possible to see something of the steps by which the pelagic habit was acquired. A tendency towards a reduction of the shell characterizes this group and culminates, eventually, in its absence in the gymnosomatous pteropods and throughout the nudibranchs. The foot also has a certain plasticity and is frequently modified by the development of parapodia or wings which, arching upwards on each side, form a cloak enclosing the shell and visceral mass as, for example, in *Aplysia* and *Akera*. In the latter, parapodia are particularly well developed, and by their means the animal can periodically, and notably in the breeding season, perform vigorous and effective swimming movements the significance of which, however, is not clear.

In the Tectibranchiata, both the Bullomorpha and the Aplysiomorpha have, apparently independently, evolved pelagic representatives, the thecosomatous and gymnosomatous pteropods respectively, and of all the gastropods which have taken to this mode of life they are, perhaps, the most specialized. *Limacina*, a primitive thecosome, is in many respects intermediate, sharing benthic and pelagic features although the animal is planktonic. It has a fully coiled shell and visceral mass, swims by means of wings, and is microphagous, but still possesses a pallial ciliary feeding mechanism. The more specialized thecosomes, such as *Cavolinia*, *Creseis* and *Cymbulia*, have a greatly reduced, paper-thin shell which is no longer coiled, and swim by movements of the extensive wings spread out laterally beyond the opening of the shell. A pallial feeding mechanism no longer occurs, and the feeding tracts are limited to the now greatly reduced central part of the foot and, in some genera, the wings as well. These are minute animals, the larger species measuring perhaps 2 cm. in length, and in all their features show a complete adaptation to a pelagic habit.

In contrast, the gymnosomes, also minute, are carnivores preying, it is thought, on the smaller thecosomes. In common with them, they possess wings which serve for locomotion and also help to keep the animal afloat, but in almost all other features they stand apart. The shell is absent, the body cylindrical and the complex buccal apparatus includes series of suckers for grasping the food and paired-hook sacs in relation to the buccal cavity. They have never developed a ciliary feeding mechanism. Although conveniently considered together, the thecosomes and gymnosomes probably represent two independent lines of evolution which parallel each other in certain respects. To place them together in one order, the Pteropoda, is probably an unnatural grouping.

The nudibranchs are more conservative and have given rise to only a few pelagic forms—the rare, transparent, brilliantly luminous phyllirhoids the modifications of which follow less spectacular lines.

Dr. Anna Bidder (Cambridge) spoke of the Cephalopoda, with particular reference to the method of swimming. Jet-propulsion, the basic swimming mechanism of the Cephalopoda, is effected in two ways. In the Nautiloidea, the non-muscular mantle of which lines the living chamber of the external shell, water enters between the overlapping folds of the funnel. Proximal 'circular' muscles provide the necessary expulsive force, and distal longitudinal muscles can be used in steering and are firmly anchored to the shell through the shell muscles. In the Belemnoidea and in all living cephalopods except *Nautilus* the shell is internal or absent. The circular fibres of locomotion constitute the mass of the muscular mantle, the major muscles of the tubular funnel are longitudinal, and both systems are anchored to the guard, phragmacone and pro-ostracum or to their derivatives when present.

Fins, first known as small posterior rounded lobes, may be regarded as stabilizers during forward movement and as assisting in gentle to-and-fro or hovering movements. Fins show a wide variety in shape, size and position; they are missing in incirrate octopods only. The deep web, characteristic of the cirromorph octopods, the Vampyromorpha, and the squid *Histioteuthis* may, Dr. Bidder suggested, serve for medusa-like swimming, especially in the Cirromorpha, the small funnel and reduced mantle aperture of which seem inadequate for locomotion. Chun's figure of "*Opisthoteuthis medusoides*" was suggested by Dr. Bidder as evidence of this type of swimming.

Dr. W. J. Rees (British Museum (Natural History)) discussed the characteristics of deep-sea cephalopods and indicated that very few species have been studied alive and that the available depth records with open nets are too few to permit precise conclusions. Likewise, records from the neighbourhood of oceanic islands are unreliable because of upwelling from deep water. Despite this, the broad picture for squids is comparable with what is known for other groups, especially fish.

Dr. Rees demonstrated that the web and arm membranes (the functions of which were discussed by Dr. Bidder) increase in size in benthic octopods and hinted that bathypelagic octopods like *Amphitretus pelagicus* may have arisen from deep-water benthic forms. *Amphitretus*, with its thick gelatinous outer covering, is the only species of cephalopod known to have 'telescopic' eyes. The most remarkable deep-sea forms, however, are the Vampyromorpha and the Cirromorpha, with their paddle-shaped fins, enormous webs and the tactile cirri on the arms. *Cirrothauma murrayi* in the latter group is very fragile and is the only blind species of cephalopod known.

Epipelagic squids of the upper 500 m. are chiefly transparent larvæ of the Cranchiidae, but deeper-living species at about the threshold of light have large eyes (sometimes accompanied by light organs) and often retain powerful toothed or hooked suckers as in *Taonius pavo*. Species living at still deeper

levels have a very varied range of light organs and are deep red to bluish-black in colour. The tentacles may become long and whip-like with minute suckers, as in *Mastigoteuthis* and *Bathyteuthis*. Accompanying these external features there are often reduction of radula and loss of ink sac, with a general degeneration of musculature which is largely replaced by a gelatinous layer. *Heteroteuthis dispar*, with its luminous secretion, often regarded as a deep-water species, is usually captured in the upper 300 m. Dr. Rees's contribution was illustrated with colour transparencies of the various species under consideration.

A short discussion followed, in the course of which Mr. B. B. Boycott (University College, London) suggested that analysis of the variety of fin sizes and shapes shown in the animals described by Dr. Bidder and Dr. Rees can be made in terms of the stability requirements of their differently shaped bodies and arms. He reported observations on *Sepia officinalis* and *Loligo vulgaris*. *Sepia* is slightly lighter than water, and relatively broad and short: the two fins are long, movable, muscular flaps, one on either side of the visceral mass. *Loligo* is slightly heavier than water, and relatively narrow and long: the two fins are triangular flaps confined towards the apex of the visceral mass. In both animals when swimming fast ('giant fibre response'), the fins are shut down against the body. When moving gently, waves pass down the fins corresponding to whether the animal is moving forward, backwards or turning. The major propulsive force in both cases is produced by jets of water from the funnel. If the fins are removed in *Sepia*, manœuvring is not much impaired, though the animal does not maintain its position in the water as well as usual but tends to drift towards the surface. The main defect is that it rolls when moving. The fins therefore give the animal lateral stability during gentle swimming. This is probably true also for *Loligo*; but since the funnel is at one end, the fins probably also serve to keep the apex of the visceral mass up when the animal is going forwards and down when it is going backwards. That this is so is indicated by the fact that the head is higher than the visceral mass when moving forwards and lower during backwards motion.

RECENT FLORISTIC STUDIES: BRAZIL, GUATEMALA AND TANGANYIKA

THE following floristic studies have recently been published.

In the Smithsonian Miscellaneous Collections (126, 1, pp. 1–290, with 128 illustrations; 1955), L. B. Smith has given a comprehensive account of the Bromeliaceae of Brazil, based on long and intensive observations. In preparing this work, the author has taken into account the particular interest of this group from the point of view of vegetative propagation, economic and horticultural uses—the pine-apple belongs here—and, in some areas, the need for eliminating bromeliads in effecting the control of malaria. A classification of Brazilian Bromeliaceae made some twenty years ago comprised some five hundred native species; but since then 135 additional species have been discovered, and others are coming to hand. An account is given of the sources of information (herbaria and earlier published work), geographical distribution and origin, and keys to the three sub-families and their genera and species, with line drawings of representative species.

A further contribution to the "Flora of Guatemala", Part II, "Grasses", by J. R. Swallen (with the section on "Bamboos" by F. A. McClure), is published as volume 24, Part II, pp. 1–390, of *Fieldiana*, 1955 (Chicago Natural History Museum). In this treatise, the author includes 120 genera and 455 species, native and introduced. This very considerable number of species is attributed in part to the diverse habitats, from tropical lowlands to sub-alpine meadows, which the territory of Guatemala provides. The largest genera are *Panicum*, *Paspalum* and *Andropogon*, these comprising about one-third of the total grass species. In conformity with the general arrangement of this Flora, the genera and species are set out in alphabetical order. An evident disadvantage of this is that certain closely related genera and species may be widely separated in the text. More than a hundred clear line drawings add to the value of this work.

The extensive hydrobiological survey of Lake Tanganyika, undertaken during 1946–47 under Belgian auspices, has yielded a further report, in which accounts are given, by different authors, of the Characeae, Hepaticae, Pteridophyta and certain families of flowering plants of the Lake region. ("Exploration Hydrobiologique du Lac Tanganika (1946–1947): Résultats Scientifiques." *Inst. Royal des Sci. Nat. de Belgique*, 4, Fasc. 2, pp. 1–82; Brussels, 1955.)

NATIONAL OCEANOGRAPHIC COUNCIL

REPORT FOR 1954–55

THE chief instrument of the National Oceanographic Council is the National Institute of Oceanography at Wormley, near Godalming, and the two main fields of study pursued at the Institute are marine biology (centred about problems concerning the Antarctic whale fisheries) and marine physics (involving mostly studies of surface waves, wind stress, and more recently, storm surges). The annual report for 1954–55, recently issued*, shows that relatively little work is done in marine chemistry and submarine geology. A comparative analysis of publications of the two leading oceanographic institutions in the United States suggests that the scientific programme of the National Institute of Oceanography most nearly resembles that of the Woods Hole (Mass.) Oceanographic Institution. The Scripps Institution, at La Jolla, Calif., places additional emphasis on biology, geology and chemistry, in descending order, and in this sense the Scripps Institution appears to present the most balanced programme. That the National Institute of Oceanography compares so favourably with the American institutions is all the more impressive when one considers that it is about one-third the size of either of them (inasmuch as budget and total number of persons employed are an index of size).

* Annual Report of the National Oceanographic Council, 1 April 1954–31 March, 1955. Pp. v+38. (Cambridge: At the University Press, 1956.) 5s. net.

The work of previous years on the measurement of ocean waves has served the National Institute of Oceanography as a nucleus for an expanding programme in the action of winds upon the sea. Directly following the Second World War, work was confined to the measurement of sea waves, computation of power spectra, and a qualitative interpretation in terms of the ocean-wide distribution of storms as revealed by weather maps. The present annual report shows that the wave studies have expanded in scope; for example, a serious attempt is being made by Dr. M. S. Longuet-Higgins to measure vertical displacement of the water surface and instantaneous atmospheric pressure at the water surface simultaneously—a type of measurement that is essential for developing a clearer physical understanding of the mechanism of wave generation. Dr. Longuet-Higgins has also developed an elegant theory of the statistical properties of a random moving surface—a form of mathematical language particularly suitable for the statement of the properties of the ocean surface and most necessary for a future physical theory of the generation, propagation and dissipation of ocean waves. Also under way are several ingenious programmes for the observation of shallow drift currents due to the wind, studies of natural oscillations and storm surges in large basins such as the North Sea, and preparations for the Institute's part in the coming International Geophysical Year.

To describe in detail each of the studies reported for 1954–55 and to name each investigator would be to reproduce the annual report in substance. My selections or omissions do not imply any evaluation or criticism; they merely reflect varying degrees of personal interest and the necessity for keeping this review brief. However, mention should be made of Dr. J. C. Swallow's newly developed neutrally buoyant float for tracing deep currents in the ocean. One hopes that the new float will lead to a reawakening of interest in the problem of the general circulation of the ocean, a problem which has lain dormant for about twenty years largely because no adequate means existed for measuring directly the deep-sea circulation. The problem of describing the deep-sea circulation accurately—and independently of present-day hypothetical elements—is of considerable practical importance because so many eyes are cast toward the oceans as a place for the ultimate disposal of wastes from nuclear reactors. It is known that certain seas, like the Black Sea, are virtually stagnant beneath the top hundred metres and that these deep waters might possibly serve as an ideal dumping-ground for large volumes of radioactive wastes, barring a climatic catastrophe and a sudden turnover of bottom water.

The deep waters of all the oceans are isolated from the surface to a much lesser extent. The question then arises as to whether one can tolerate a fairly high level of radioactive waste in the deep ocean water without contaminating the surface. The oceanographer cannot at present give an affirmative answer to this question, but certainly Dr. Swallow's new device is the first glimmer of hope that we shall soon describe deep-sea currents more accurately. Before the War most of the effort of oceanographic institutions was directed toward exploring the large-scale ocean circulation. At present, only about 5 per cent of the publications issuing from the National Institute of Oceanography and from the Scripps Institution of Oceanography concern the general circulation of the ocean. The percentage from the Woods Hole Oceanographic Institution averages somewhat higher, due probably to its proximity to the Gulf Stream. The present paucity of investigation of the really deep sea in Britain and the United States will doubtless be remedied through the stimulus of such new techniques as that of Dr. Swallow, because of the increasing pressure for definite information from those concerned with nuclear energy and as a result of theoretical advances in dynamical meteorology. Henry Stommel

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CARNEGIE UNITED KINGDOM TRUST

REPORT FOR 1955

THE forty-second annual report of the Carnegie United Kingdom Trust, covering the year 1955*, is of special interest for its review of the quinquennium 1951–55, during which grants totalling £558,495 were paid, and for the statement of policy for the next quinquennium, which is appended. The development of the visual arts scheme, which was a new venture during 1951–55, has been most encouraging, and a larger allocation is contemplated in the new quinquennium. New life has been infused into many small museums, which have been converted into lively centres of culture and of education through recreation, and the Trust has joined with the Museums Association in urging on the Government the need for State aid to the national museums as the only real hope of retrieving a serious situation. In the field of community services the largest single determining factor during the past five years has been the Trust's awareness that problems of material want have given place to problems of personal, family and community relations, and both the Community Services Committee and the Education Committee have been concerned with research into the causes of social problems arising in families, into the effectiveness of new techniques for dealing with family problems, the development of family case-work agencies, experimental projects for restoring problem families to health, demonstration homes for delinquent boys and for the homeless sick, re-training of social workers and counsellors and the development of a new university course designed to produce general practitioners in social work.

The rehousing of the Scottish Central Library and several other building projects accounted for half the Trust's expenditure during the quinquennium, but the passing of legislation which brought the Scottish Central Library, during 1955, into financial independence of the Trust completed the Trust's historic contribution towards the development of the public library system. Building projects which the Trust has recently supported are used for housing its beneficiaries or for accommodating services it wishes to support, and have been designed to meet needs which have not so far been comprehended in the provisions of the Welfare State; the Trust also emphasizes its intention to keep a proper balance between rescue work and amenity.

The statement of policy for the quinquennium 1956–60 points out that the Trust prefers to con-

* Carnegie United Kingdom Trust. Forty-second Annual Report, 1955. Pp. viii+92 (9 plates). (Dunfermline: Carnegie United Kingdom Trust, 1956.)

centrate its resources in limited fields where it can make an effective contribution to development, and that in selecting projects it distinguishes two main types: development work which is carried out over the country as a whole; and experiment or investigation, which may be carried out on a local basis but with the hope that the results may be of general application and usefulness. The main branches of activity for which part of the Trust's funds have been allocated for this current quinquennium are six in number: the encouragement of amateur music and drama activities; the encouragement of the practice of the visual arts by amateurs through grants towards the cost of occasional expert tuition for groups of three or more art clubs; the development of the local museum service, in co-operation with the Museums Association; the support of the National Councils of Social Service; the support of the efforts of the Family Welfare Association and Family Service Units to improve the quality of family life; and projects selected by the Trust to encourage outdoor group activities. In this connexion, the Trust hopes to contribute to the resources of a national park or a national forest park and to increase the value of the parks, as well as to assist field-work in the biological sciences and archæology, and a sum of £50,000 has been provisionally earmarked for expenditure on such schemes.

Reviewing the work in 1955, the report records the award of grants to sixteen museums and of exceptional grants, each of £1,000, to the Highland Folk Life Museum at Kingussie and to enable the Bowes Museum at Barnard Castle to remain open. Grants were also given to students and to museum officials to enable them to widen their professional and technical knowledge. During the past ten years nearly a hundred museums have been assisted to reorganize their basic layout, and a sum of £50,000 has been allocated for such purposes for the 1956–60 quinquennium. Support of the visual arts is being continued on the usual lines, and £15,000 has been allocated for the purpose.

The report expresses the hope that the plans which the Executive Committees of the National Councils of Social Service are now considering for increasing their free income will soon produce results commensurate with the public services it performs, but meanwhile the Trust is increasing to £8,600 its total contribution for this service in the quinquennium. The Family Welfare Association's general-purpose grant has been renewed at £2,000 for 1956, £1,750 for 1957 and £1,500 for each of the following three years, and £10,000 has been set aside for the further development of Family Service Units, of which there are now eleven established on a permanent basis in reasonably well-equipped centres, with warm support from the local authorities. A grant of £5,000 over five years was made to the Liverpool Research Service Society for the purchase and equipment of sub-standard working-class houses for the accommodation and training of homeless families, and satisfactory progress is reported. A final grant of £1,500 was made for the blind-deaf machine, 'Arcaid', to be administered by the National Institute for the Deaf. The first group of twenty-five students completed, in the summer of 1955, their four years course of training as social workers at the London School of Economics, to which the Trust made a grant of £20,000 in 1953, and a second group started in October 1955. The Trust has also agreed to finance for five years, at a cost of £25,000, the Bristol Social Project which has as its main objects the investigation of stresses and strains in a developing community and their practical prevention and control and the education of the community to a higher level of responsibility.

THE GOLGI APPARATUS AND THE ELECTRON MICROSCOPE

By Prof. J. BRONTË GATENBY and R. G. LUTFY*
Trinity College, Dublin

IN 1951, A. J. Dalton[1] first made satisfactory electron pictures of the Golgi apparatus. In 1953, Dalton and Felix[2] published an important memoir on the Golgi apparatus of the epithelial cells of the epididymis and duodenum of the mouse. Those who previously had at their disposal only the light microscope found much food for thought in this work. Dalton and Felix described the small granules (or Dalton–Felix bodies) which probably always are associated with the Golgi apparatus. They showed that the net type of Golgi apparatus found in the epididymis really consists of a series of hollow tubes, in section much thicker on one side than the other, their cavity filled by more or less compressed vacuoles in chain form (Fig. 1). The wall of these tubes consisted of double lamellæ sweeping along the length of the Golgi apparatus. Their work agreed in broad details with the previous light microscope study by Nassonow[3]. Outside the Golgi apparatus were found comparatively large bodies which stain with neutral red and methylene blue, probably of a nutrient nature (lipochondria ?). The double membranes have also been described by French and Swedish workers, of whom Johannes Rhodin[4] may be mentioned for his study of the cells of the convoluted tubes of the kidney.

None of this work, however, answered completely some important questions which have arisen in recent years. Three of these are the supposed relation between the commonly occurring dictyosome of invertebrate somatic cells, and of all animal male germ cells, and the Golgi apparatus of higher vertebrate neurones; another, the supposed relation between secreted material and the Golgi apparatus. Work on the latter with special reference to the pancreas has been recently dealt with by one of us[5]; a paper by Sjöstrand and Hanzon[6] not accessible to us should be consulted in addition. Another puzzling question was the nature of the so-called chromophobe part of the dictyosome, which usually had been assumed to be a coagulable material, which formed a greyish inner mass, as observed in osmium preparations under the light microscope. If this mass was an intrinsic coagulable part of the dictyosome and not vacuolar and watery, it became difficult to

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homologize the dictyosome and the conventional vertebrate canalicular apparatus of Golgi as conceived by Cajal, and generally speaking proved correct by Dalton and Felix[2].

It is difficult to make satisfactory line drawings of electron photographs because of their fine ground detail. Figs. 1–6 are of the epididymis[3], the cricket spermatid (Beams, Tahmisian, Devine and Anderson, unpublished), the *Stronglycentrotus* egg (Afzelius, unpublished), the sponge *Grantia*[7], a human breast cancer cell[8] and the kidney tubule cell[4]. Now in no case does the cavity of the Golgi apparatus (*V*) show any coagulum. This would appear immediately to rule out the older view that secreted material appears inside Golgi canals or vacuoles. At least one convincing exception to this is the Golgi spaces of the bile ducts in liver cells[5]. The contractile vacuole (cortex and vacuoles) of the freshwater sponge and Protozoa does not stain vitally in neutral red, and so far as we know neither does any one of the included spaces (*V*) in Figs. 1–6. Turning now to the very interesting electron photograph of the cricket (*Nemobius*) spermatid dictyosome, Fig. 2, we have the usual arrangements of an included chain of vacuoles, a cortex of double membranes different and spongy on the right side of the figure, and on the extreme left a group of granules varying in size from the usual Dalton–Felix type to larger vesicles (micro-vesicles); this then is a dictyosome with four parts. Beams *et al.* consider the micro-vesicles to be pro-acrosomic, and we agree. In other photographs obtained by Beams and his group, this spherical area of micro-vesicles is found to have become surrounded by a wall, and is then undoubtedly the acrosome just before its adherence to the spermatid nucleus. At this stage the large, presumably watery vacuoles (*V*) included in Fig. 2 have almost completely disappeared. In the spermatocyte, Beams *et al.* have shown that prior to the maturation divisions the vacuoles (*V*) are ready and developed. Thus part of the preparation for the final stages of acrosome secretion appears to be the accumulation of water in the dictyosomes. It is to be hoped that further information on this point will be obtained by Beams's group. It would now appear that the site of acrosome secretion primarily is at the outside, and not the inside, of the dictyosome, and that the current idea that the dictyosome actually secretes the acrosome may need to be modified. Moreover, it is now apparently not possible to believe that the dictyosome is dehydrating the forming acrosome[6].

The electron photograph by Afzelius of the echinoderm dictyosome is interesting because the spaces which presumably could later swell up to form the chain of vacuoles clearly appear not within the double membrane, but between pairs of membranes

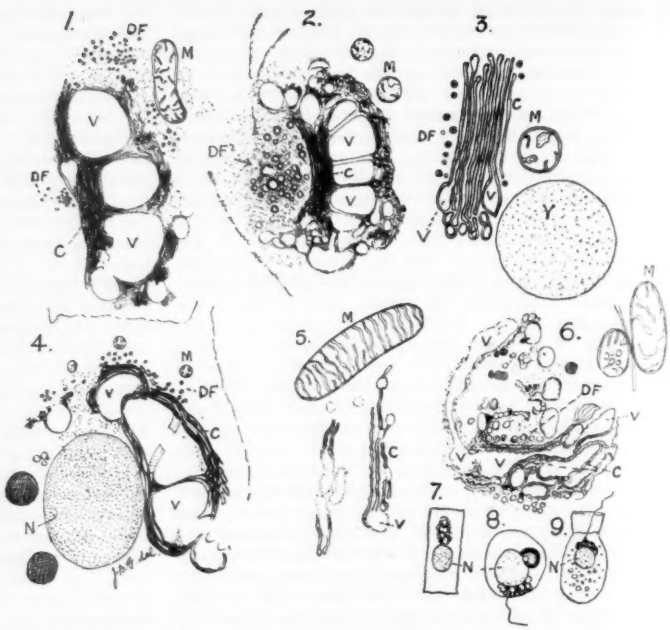

Fig. 1. Part of the Golgi net of the epididymis (Dalton and Felix). Fig. 2. Spermatid dictyosome of the cricket, *Nemobius* (Beams, Tahmisian, Devine and Anderson). Fig. 3. Dictyosome of oocyte of *Stronglycentrotus* (Afzelius). Fig. 4. Dictyosome of *Grantia* choanocyte (Gatenby, Dalton and Felix). Fig. 5. Convoluted tubule cell of rabbit (Rhodin). Fig. 6. Human breast cancer, cell of a metastasis (Haguenau and Bernard). Fig. 7. Type vertebrate epithelial cell showing net apparatus above nucleus; Fig. 1 refers to part of net. Fig. 8. Insect spermatid with dictyosome on right of nucleus; refers to Fig. 2. Fig. 9. Sponge choanocyte with dictyosome; refers to Fig. 4. Fig. 6 is a cross-section of entire Golgi apparatus with elongate canal (cavern). Figs. 7–9 are from cells seen living with phase contrast

M, mitochondrion; *C*, cortical membranes; *DF*, Dalton–Felix bodies; *Y*, yolk sphere; *N*, nucleus; *V*, vacuole, cavern, canal

(Fig. 3). The same appearance is found in Rhodin's examples of kidney tubule cells, in Beams's material and in Lacy's pictures of the dictyosomes of *Patella vulgata* neurones (unpublished work).

In the past there have been differences of opinion as to the morphology of intra-cellular bodies, living or fixed, and studied with the light microscope. The electron microscopists use much thinner sections, and their results are not always easy to interpret. This certainly applies to the three distinct parts of the *Nemobius* dictyosome (plus acrosome) of Beams *et al.* (Fig. 2).

The following conclusions seem possible at this stage of work. (*a*) The cavities of the Golgi apparatus do not become filled with secretion. (*b*) The chromophile part of the Golgi apparatus is the double membranes or cortical substance, whereas the chromophobe part appears to be a system of caverns (Cajal) presumably filled with water. (*c*) Secretion takes place near but not in the Golgi apparatus, as if from the ground cytoplasm or from the mitochondria (pancreas), or perhaps from detached parts of the double membranes (Dalton–Felix bodies). (*d*) Neutral red used vitally does not initially stain the cortical substance or the chromophobe (vacuolar part), but does stain either the early secretion or mitochondria possibly when changing into secretion[9]. (*e*) The arrangement of the dictyosome into cortical substance and Dalton–Felix or small granules is the same probably from Protozoa, and certainly from sponges, up to mammalian cells. A single vacuole or

chains of watery vacuoles may develop between the pairs of cortical membranes, but are not always present. These spaces apparently represent the cavity of the protozoan contractile vacuole. (*f*) The Golgi apparatus of the neurone is like that of Rhodin's kidney tubule cells (Fig. 5) and Haguenau and Bernard's cancer cell (Fig. 6), that is, a series of very long double lamellated membranes, with or without enclosed and neighbouring chains of caverns and vacuoles[9,10].

The arthropod and molluscan dictyosomes in a testis viewed with the light microscope are always approximately the same size at a given stage (Fig. 8). As might therefore be expected, the number of double membranes (that is, paired membranes) seems fairly constant for the invertebrate dictyosome, there being about twelve in both *Helix aspersa* and *Lumbricus terrestris* spermatids[10], 8–10 in the *Strongylocentrotus* oocyte dictyosomes (Afzelius, unpublished), and about 6–8 in the *Nemobius* spermatid dictyosome (Beams *et al.*). P. Grassé, N. Carasso and P. Favard[11] have published pictures of the *Discoglossus pictus* spermatid dictyosome with only four very clear membranes; in the rat neurones (Palay and Palade[6]) four or five pairs are present. There are about 6–8 in the late acrosome stage in the mouse spermatid[10]. In the mouse kidney tubule[4] there are membranes consisting of 2, 3 or 4 pairs. The cerebral cortex neurones of the mouse, in the one photograph we have seen, have similar 'strings' of 2–6 pairs of membranes[10]. In the pictures of *Lumbricus* and *Helix*, the membranes are piled in a pyramidal shape, the conventional curved outline of the living dictyosome under phase being brought about by the graduated lengths of the individual pairs[10]. Where vacuoles exist between members of pairs, the count is often difficult to make, especially where the lamellæ are more delicate and thinner in section, as in *Nemobius* (Beams *et al.*).

On the question of the nature of silver and osmium impregnation of the Golgi apparatus, which is remarkably specific, despite what has been written in controversy by some authors, it seems obvious that both the metallic and hæmatoxylin methods depend on a reaction on or in this system of close membranes.

Finally there is one question which cytologists who have no electron microscope are bound to ask. Is it worth while going on with the light microscope in any of its present various forms? After having studied electron photographs made recently by various workers, it has been concluded that the light microscope is useful for finding problems to be investigated properly by the electron microscope.

We thank Drs. Dalton, Felix, Afzelius, Lacy and Haguenau and Prof. Beams and his associates for generously sending some of their unpublished work with comments for our study. It is possible that these workers may not agree with some of our observations on the information they have been able to supply in this field.

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HISTOCHEMISTRY OF MUCOPOLYSACCHARIDE-LIKE SUBSTANCES AND ALKALINE PHOSPHATASE IN MADREPORARIA

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MUCOPOLYSACCHARIDE-LIKE compounds and non-specific phospho-monoesterases (phosphatase)[1] have been found to occur in Madreporaria. Histochemical investigations were undertaken to localize these substances in the polyps of thirty-two species of corals belonging to twelve families. All but eight of the species were tropical reef-builders collected in Jamaica. Of the non-reef-building corals, two were collected in Jamaica, three in British waters and three near Naples, Italy.

(1) *Epidermis:* The columnar supporting cells were strongly positive to phosphatase and periodic acid–Schiff tests, and orthochromatic with respect to toluidin blue. In the Dendrophylliidae, the epidermis contained little or no phosphatase activity. The mucus glands were phosphatase and periodic acid–Schiff negative but possessed an intense purplish-red γ-metachromasia. The granular glands in the stomodeal epithelium were phosphatase negative, positive to the periodic acid–Schiff test and displayed an intense purplish-black β-metachromasia. Nematocysts of the spirocyst variety were negative to phosphatase tests, faintly positive to the periodic acid–Schiff test, and were virtually unstained with toluidin blue.

(2) *Mesoglea:* This was phosphatase-negative, orthochromatic with toluidin blue and strongly stained by the periodic acid–Schiff test. The last reaction was localized both in the fibrillæ and the acellular ground substance.

(3) *Gastroderm:* The epithelial cells showed very high alkaline phosphatase activity. They also stained strongly with periodic acid–Schiff and exhibited orthochromasia with toluidin blue. In the cytoplasm of the mature ova, phosphatase and periodic acid–Schiff activities were concentrated in a narrow zone around the yolk droplets. The septal filaments and lateral mesenterial lobes, the 'absorptive zone' of Yonge and Nicholls[2], possessed higher phosphatase and periodic acid–Schiff activities than any other structure in the coral polyp. The phosphatase-negative zooxanthellæ were invariably surrounded by a strongly phosphatase-positive gastrodermal reticulum in intimate contact with the algal

surface. The large nematocysts and hyaline glands of the septal filaments were phosphatase-negative and stained only weakly with periodic acid–Schiff. None of these structures displayed metachromasia. Contractile tissue, especially the fibres of the septal retractor muscle, exhibited high phosphatase activity but stained very little with periodic acid–Schiff. The staining properties of the mucus and granular glands in the gastrodermis were the same as those for similar glands of the epidermis.

The material of the mesoglea, epidermis and gastrodermis reactive to periodic acid–Schiff showed the histochemical properties of neutral mucopolysaccharide in that it was non-metachromatic, resistant to amylase and unaffected by peptic and tryptic digestion. The material in the granular glands reactive to periodic acid–Schiff is probably a kind of acid mucopolysaccharide due to its strong metachromasia. In all cases, the periodic acid–Schiff reaction could be blocked by acetylation[3]. The pyrenoids of the zooxanthellae contained an amylase-soluble material that reacted strongly with periodic acid–Schiff. Droplets of a similar material were also observed in the lateral lobes at the base of the septal filaments. These were found only in the presence of disintegrating zooxanthellæ in process of extrusion; hence it was concluded that the amylase-soluble material reacting with periodic acid–Schiff found at this site was not glycogen but amyloid liberated by broken-up zooxanthellæ, It is probable that the compound identified by Hosoi[4] as glycogen in *Fungia actiniformis*, a coral containing zooxanthellæ, was in fact amyloid of algal origin.

The metachromatic substances in mucus have been provisionally identified as simple acid mucopolysaccharides; but the nature of the acid mucopolysaccharide-like material in the granular glands is unknown. Preliminary studies indicate that the granular glands discharge during feeding, and that the mucus extruded at this time contains acid phosphatase.

One of the striking results of this investigation is the one-way correlation between the presence of extranuclear alkaline phosphatase and the distribution of a neutral mucopolysaccharide-like material in coral. Moog and Wenger[5] found a similar relationship in a wide variety of invertebrate and vertebrate tissues. They suggested that the mucopolysaccharide associated with phosphatase forms part of a cytoskeleton upon which enzymes may be attached in specific ways to provide suitable conditions for their activities. The localization of the phosphatase–mucopolysaccharide complex at epithelial and other selectively active surfaces in corals indicates that this enzyme may be connected with active transport. The phosphatase in the gastroderm is presumably related to food absorption; but the presence of the enzyme in the epidermis is enigmatic. It is suggested (1) that the enzyme may be concerned with flagellar movement, (2) that it may play a part in the formation and extrusion of mucus, and (3) that absorption of food and other substances may occur directly through the epidermis. The last postulate has received some support from two separate lines of evidence. It is a well-known fact that some faviid and mussid reef corals[6] can perform extracœlenteric digestion by means of septal filaments extruded through temporary openings in the edge zone of the cœnosarc. Thus, the possibility exists that direct epidermal food absorption may occur. Electron-micrograph studies have shown that the free border of the supporting cells has closely spaced filiform processes which may be an adaptation for more efficient absorption of substances from the external medium[7].

Thanks are due to the Challenger Society, the Browne Fund of the Royal Society, and the British Association for support of various phases of this work, which was part of a Ph.D. thesis presented to Yale University. A detailed report of the histochemical findings will be published elsewhere.

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MEASUREMENT OF THE THICKNESS OF THIN FILMS BY MULTIPLE-BEAM INTERFERENCE

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THE multiple-beam interference method for the measurement of the thickness of thin metallic films developed by Tolansky[1] is now a well-established technique. The film, the thickness of which is to be measured, is deposited on a substrate, part of which is covered to give a sharp edge to the film. An opaque metallic reflecting layer is then deposited over the edge of the film. The step in this overlayer is measured by using it as one surface of an interferometer and viewing the multiple-beam fringe system in reflexion. Provided that the overlayer assumes the exact contour of the surface, this step-height will give the thickness of the film underneath.

Tolansky has given adequate evidence that silver fulfils the necessary requirements both in its high reflectivity and its ability to contour the surface. Some workers have tried metals other than silver, using fringes of equal thickness[2,3] and fringes of equal chromatic order[4]. In both fringe systems the displacement of the fringes at the discontinuity caused by the step-edge gives the height of the step in the opaque layer. However, Avery[2] has shown that the thickness of a silver film as measured by multiple-beam interference may vary considerably with the metal used for the overlayer. It was found that the value for the thickness of a silver film was 25 per cent greater when measured using a chromium

overlayer than the thickness when measured with a silver overlayer. Avery explained this discrepancy by considering the silver film to have an aggregated structure[2]. He suggested that atoms of silver would enter the interstices of a silver film more easily than atoms of chromium, and that this would lead to a 'packing-in' effect for silver on silver but not for chromium on silver. Another explanation for this discrepancy was put forward by Scott, McLauchlin and Sennett[4]. They suggested that the structure of the chromium overlayer adjacent to the substrate might be less aggregated than that of the silver film; but no further experiments were carried out to check the results of Avery.

The occurrence of this discrepancy was not confirmed by Heavens[3]. No evidence of 'packing-in' of the atoms of the overlayer material into the interstices of the film was observed. This disagreement may be due to the experimental conditions employed by each worker, and the lack of these details in the work of Avery makes comparison of the results very difficult.

Experiments have been carried out in this Department on the measurement of the thickness of thin silver films, using both silver and chromium as the overlayer material. A standard experimental procedure was adopted for the deposition of these films, which were evaporated on to selected glass microscope slides. Fig. 1 shows the position on the substrate of the silver film (W), and the overlayer films of silver (X) and chromium (Y). These three films were deposited in succession without admission of air between evaporations. A mechanical device was used to arrange the slide normally above each source in turn, at a distance of 30 cm. Assuming a point source, the maximum possible variation in thickness over the whole surface would not exceed 1 per cent. Since the silver film is symmetrically placed with respect to the silver source, the thicknesses at the two ends should be identical, and this was confirmed within experimental error. The slide was cleaned with 'Teepol', hydrogen peroxide (20 vol.), dried with cotton wool, and polished with lens-cleaning tissue. The surface was finally cleaned electrically *in vacuo*. The films were deposited at a pressure of 10^{-4}–10^{-5} mm. mercury. In view of its marked effect on the structure of thin metallic films[5], the rate of evaporation was considered an important experimental condition. Silver films were deposited at evaporation-rates between 1 and 60 A./sec. approximately. In each case the rates of evaporation of the silver and chromium overlayer films were kept constant at approximately 20 A./sec. and 3 A./sec., respectively. The thicknesses of the silver films were measured by multiple-beam interference fringes of equal thickness viewed in reflexion.

The results of these investigations are shown in Table 1. They indicate that when the chromium overlayer is opaque, then there is no discrepancy in the thickness of the silver film as measured by the two different overlayers. However, when the chromium overlayer is not opaque, then a discrepancy of the type found by Avery occurs. The variation of the rate of evaporation of the silver film appears to have no effect on the results. The first two tests in Table 1 are with a non-opaque chromium overlayer, whereas the remaining tests are with opaque overlayers. The discrepancy in the thickness of the silver film as measured by X and Y is expressed as a percentage of X.

Table 1

Thickness by X (A.)	Thickness by Y (A.)	Thickness by Z (A.)	Discrepancy $\frac{Y-X}{X}\times 100$	Discrepancy $\frac{Z-X}{X}\times 100$	Rate of evaporation (A./sec.)
337	395	326	17	3	28
461	562	454	22	2	22
203	215	216	6	6	11
245	262	240	7	2	3
456	466	427	2	6	35
577	620	613	7	6	16
939	924	958	2	2	57

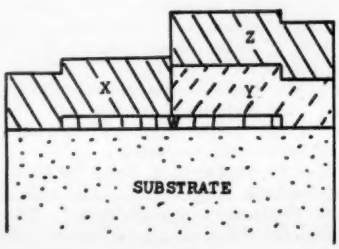

Fig. 1

Schulz and Scheibner[7] have shown that when a beam of light strikes a metal film at normal incidence, the phase change at reflexion can be related to the thickness of the film. This phase change becomes constant at a certain film thickness, in the case of silver at 500 A. It can be assumed that there is a similar thickness for chromium, and for films below this critical thickness the phase change will be affected by the underlying film or substrate. The discrepancy in the thickness measurements when a non-opaque chromium layer is used may then be caused by a difference in the phase change at reflexion on the two sides of the step-edge since the underlying substances are different. That is, the fringe displacement at the step-edge would consist of the displacement due to the thickness of the silver film plus a displacement due to a difference in phase change.

This proved to be the case. An opaque silver layer (Z in Fig. 1) was deposited on the chromium overlayer; when the step in this layer was measured, a thickness for the silver film (W) was obtained which agreed with that as measured by the silver overlayer (X), as shown by the first two sets of results. It is concluded that the disappearance of the discrepancy after this final evaporation is due to the elimination of the difference in phase change. This conclusion is supported by the results of tests with an opaque chromium overlayer. There is then no change in the measured thickness value when the silver layer (Z) is deposited on the chromium. The measured height of the step in this layer is in good agreement with the values given by the silver and chromium overlayers X and Y.

The investigation is being continued to determine the critical thickness of chromium and the variation of phase change at reflexion with thickness.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Bone treated with Ethylenediamine as a Successful Foundation Material in Cross-Species Bone Grafts

The optimal bone graft is one which is most readily: (1) accepted with least reaction, (2) incorporated in callus formation, (3) vascularized with subsequent mineralization, and (4) absorbed (remodelled) by the host. Assuming that the constituents of bone which cause failure are contained in the organic fraction (antigens, fats, mucopolysaccharides, etc.), its removal would allow host acceptance of foreign bone. The remaining inorganic matrix might then be suitable for surgical prosthesis in situations where 'banked' bone is now required. The use of such inorganic bone transplants would, in addition, alleviate the present problems of procuring, storing and supplying whole bone.

Preliminary studies will be reported in which the inorganic matrix of heterologous bone prepared by ethylenediamine extraction was transplanted successfully. It is generally conceded that fresh autogenous bone is optimal for bone grafting. However, conditions do occur which make its use unfeasible. This would be particularly true in a national emergency. It is obviously desirable to have readily available a supply of bone graft material.

Past methods for removal of the organic fraction, which would include any antigenic constituents, have so altered the bone that it differed in composition and/or structure from that of the original bone[1-3]. Recently, Williams and Irvine[1], Peckham and Losee[4], and Singer and Armstrong[5], using ethylenediamine as the organic extractant, removed the organic material of bone with little or no change in the cation or anion composition or the X-ray diffraction powder pattern of the residue. Even the carbonate fraction, which is rather easily lost, apparently remains intact.

Other factors being equal, the speed with which acceptance, revascularization, absorption and perivascular new bone formation take place in a bone graft depends upon the ease with which the osteogenic tissues of the host can penetrate and gain attachment to the graft. With the removal of the organic constituents, bone attains an enormously increased free surface area immediately available without the need for biological debridiment (100 sq.m. per gm.)[6].

The bone used in the present work was extracted in a Soxhlet apparatus with a mixture of 14 ml. triple-distilled water and 86 ml. ethylenediamine (95–100 per cent, Eastman) for 48 hr., followed by absolute alcohol for 4 hr. (5–7 gm. bone). The latter treatment assures removal of any residual ethylenediamine, ethylenediamine carbonate, water, fat and an apparent hæmatin complex resulting from the action of ethylenediamine on red blood cells. The relatively low temperature (90–95° within the bone) required to distil the ethylenediamine results in minimal alteration in composition and structure of the inorganic matrix. After extraction, the prepared bone has a nitrogen content of less than 0·4 per cent, is very white, apparently bacteriologically sterile, and retains its form. It can, however, be readily shaped with a scalpel. The treated bone can also be sterilized by boiling or autoclaving without change in the nitrogen, calcium, phosphate, or ash composition.

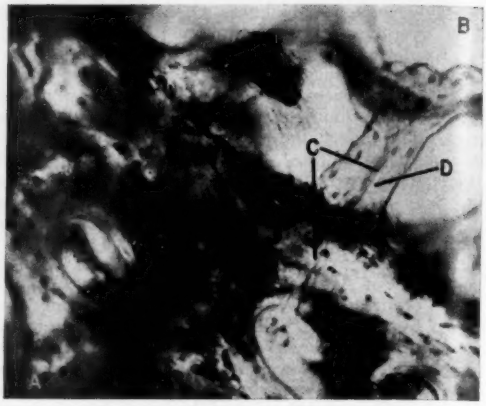

Fig. 1. Histological section of nine-week graft (hæmatoxylin and eosin). Section 100μ thick of bone demineralized with ethylenediamine-tetraacetic acid. Host bone (*A*) supplying blood vessel (*C*) for perivascular new bone formation (*D*) in "ED bone" graft (*B*). Notice vital bone cells in new bone (*D*)

Cortical defects (20 mm. × 5 mm.) were made in the shaft of the dog's tibia and filled with inlay grafts of rat femur and bovine cortical femoral bone treated with ethylenediamine. Weekly radiographs were taken and intraperitoneal injections of alizarin red *S*, a dye having an affinity for new bone growth, were given. Six dogs received rat femoral bone grafts and four dogs received bovine femoral cortical strips as donor material. The rat bone grafts were in place six weeks and the bovine bone grafts nine weeks. Gross and histological evaluation of the grafts including microradiography[7] indicated apparent acceptance in all cases. A significant amount of reactive bone formation was clearly demonstrated by the presence of alizarin red *S* at each graft site. All grafts were covered with and included in callus formation. There was no evidence of foreign body reaction nor sequestration. Repair was carried out by an active invasion of blood vessels, connective tissue, and tissue fluids from the host into the spaces of the grafted bone formerly occupied by organic material (which represents about two-thirds of its original volume[8]). Almost complete revascularization was noted in the graft of treated bone as early as six weeks following implantation. Extensive absorption of the mineral elements of the graft occurred without the presence of osteoclasts. Absorption was followed by a significant degree of perivascular new bone formation (Fig. 1).

If further study substantiates preliminary findings, it appears that unlimited sources are immediately available for the preparation and storing of sterile supplies of bone-graft material.

We wish to thank Dr. S. N. Stein for his encouragement and valuable suggestions. The able assistance of Lieut. S. Peckham is acknowledged. The opinions or assertions in this communication are the private ones of the writers and are not to be construed as

official or reflecting the views of the U.S. Navy Department or the Naval Service at large.

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Bethesda, Maryland. Feb. 9.

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Two-Dimensional Electrophoresis of Serum Proteins

A METHOD of zone electrophoresis in starch gels has recently been described by one of us[1]. The high degree of resolution obtained with this method when applied to serum appears to be due to the use of a supporting medium the pore size of which approaches the molecular dimensions of some of the proteins involved, so that resolution by molecular sizes is superimposed on resolution by free solution mobilities. Consequently the starch-gel electrophoretic separations result from a qualitatively different process from that involved in free-solution electrophoresis. A combination of the two electrophoretic processes at right-angles should therefore give a much greater degree of resolution than is possible with either separately. Such a two-dimensional electrophoretic system has been tested by us, using electrophoresis on filter paper as a close approximation to that occurring in free solution. The present communication illustrates the type of result which can be obtained; a detailed description of the method will be published later.

The first electrophoresis is carried out on a 5-mm. wide strip of Schleicher and Schüll 589 *YD* filter paper using a buffer of *p*H 8·55 (Poulik, M. D., unpublished work) and of ionic strength approximately 0·1, prepared from Michaelis stock solution[2] by the addition of hydrochloric acid. The strip with the serum proteins separated according to their free-solution mobilities is then inserted into a starch gel 12 cm. in width, and a second electrophoresis is carried out at right-angles to the first.

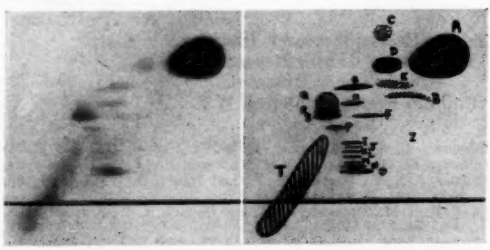

Fig. 1. Two-dimensional electrophoresis of normal human serum of group II*B* (left) and key (right). *A*, albumin; *B*, a component unresolved from albumin and α_1-globulin on filter paper; *C*, *D* and *E*, α_1-globulin; *F*, a component unresolved from α_1- and α_2-globulins on filter paper; *G* to *O*, α_2-globulin; *P*, a component unresolved from α_2- and β-globulins on filter paper; *Q*, *R* and *S*, β-globulin; *T*, γ-globulin. *Z* is a shadow introduced in the photographing and should be disregarded. The black line across the photograph indicates the position of insertion of the filter-paper strip

The gel is made and stained in the way described in the previous publication[1] and the starch-gel electrophoretic conditions are the same as described there for serum protein separations.

A photograph and explanatory diagram of the results obtained with 0·01 ml. of normal human serum of group II*B* [1,3] are shown in Fig. 1. More than fifteen resolved components can be seen even at the present stage of development of the method. The full significance of these results will be discussed in the later paper. However, we should like to point out that, in addition to an improvement in the resolutions which can be obtained, information on the distribution of molecular sizes in the various electrophoretic fractions results from this new method. For example, the α_2-globulin fraction obtained in the first filter-paper electrophoresis is resolved into more than six components by the second starch-gel electrophoresis. This indicates that there are more than six molecular size-groups present in the α_2-globulin of serum from the individual here concerned.

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Fractionation of Deoxyribonucleic Acid by Physical Procedures

THE use of an ultra-violet light absorption system for determining the sedimentation characteristics of deoxyribonucleic acid at low concentrations has already been described[1]. Further work has shown that the sedimenting boundary is stable and that the measurements can be made at concentrations of deoxyribonucleic acid as low as 10^{-5} gm./ml. It has been found for five preparations from calf thymus which have been studied[2] that the distributions of sedimentation constants at infinite dilution (for solutions in 0·2 *M* sodium chloride) covered a range from $S_0 = 10$ to at least $S_0 = 40$, and that the individual distributions differed significantly, the average sedimentation constant varying from $S_0 = 23$ to $S_0 = 29$.

To confirm that this observed distribution was due to a true heterogeneity, a solution of deoxyribonucleic acid (0·007 per cent) in 0·2 *M* sodium chloride was centrifuged in a bucket rotor for a sufficiently long time to remove all the material with $S > 20$. The supernatant was allowed to stand for 24 hr. at 4° C. and the distribution of the sedimentation coefficients was then determined. It was found that the average sedimentation coefficient was reduced from $S = 19$ to $S = 14$, and only 4 per cent of the deoxyribonucleic acid had a sedimentation coefficient greater than $S = 20$ (Fig. 1*a*). This shows that the observed distribution of sedimentation coefficients is real and also that there is no tendency for the particles of low sedimentation coefficients to aggregate on standing.

In order to determine to what extent variations in the distribution can arise during the preparative procedure, curves for the distribution of the sedimentation coefficients for the deoxyribonucleic acid in the nucleoprotein and at various stages during the removal of protein have been determined by carrying out experiments in 2·5 *M* sodium chloride, a salt concentration at which the dissociation into deoxy-

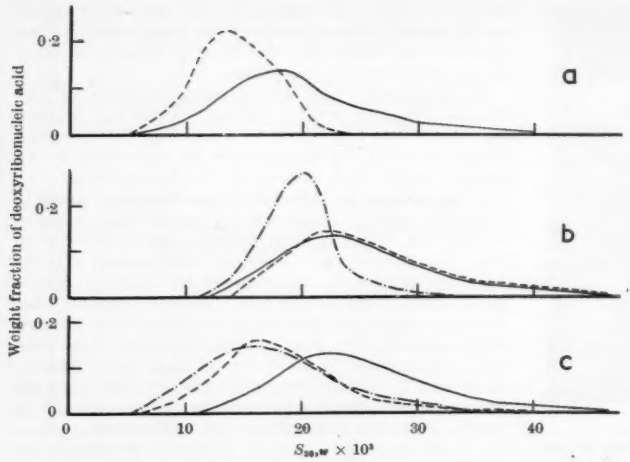

Fig. 1. Normalized distribution curves of sedimentation coefficient for deoxyribonucleic acid (DNA). The area under each curve is the same. (*a*) ———, 0·007 per cent DNA; – – – –, DNA fraction obtained after centrifuging to remove material with $S > 20$. (*b*) ———, DNA in nucleoprotein; – – – –, DNA prepared by the detergent method; —·—·—, DNA prepared using amyl alcohol and chloroform. (*c*) ———, DNA in nucleoprotein gel; —·—·—, DNA in soluble component of nucleoprotein; – – – –, DNA in nucleoprotein gel after gel has been standing for 10 days at 4° C.

ribonucleic acid and protein is substantially complete[3]. These distributions were then compared with that observed for the final product of deoxyribonucleic acid after drying in alcohol and acetone and redissolving. Using the method of Kay *et al.*[4], in which protein is removed using the detergent dodecyl sulphate, it was found that no marked change of the distribution curve occurred at any stage during the preparation. The distribution of sedimentation coefficients for the deoxyribonucleic acid in the nucleoprotein and for the final product is shown in Fig. 1*b*. On the other hand, when deoxyribonucleic acid is prepared by the Sevag procedure[5], in which protein is removed by denaturation with amyl alcohol and chloroform, much of the material of high sedimentation coefficients is lost during the first two extractions. It can be concluded that using this method of preparation produces a fractionation of the deoxyribonucleic acid rather than a degradation or denaturation, since (*a*) after the first two extractions further treatment does not affect the distribution, (*b*) deoxyribonucleic acid of higher sedimentation coefficients can be removed from the denatured protein residues and (*c*) transforming principle when prepared in this way retains its biological activity[6]. It has been reported that deoxyribonucleic acid prepared by this method has a lower molecular weight than that prepared using the detergent method[7]. Analysis of the base composition of deoxyribonucleic acid prepared by these two methods and of that from the denatured protein residues of the Sevag extractions showed no significant differences. This confirms the conclusion of Lucy[8] that there is no marked correlation between the size of the deoxyribonucleic acid particles and their base composition.

Previous work[9] has shown that when nucleoprotein is dispersed in water, in addition to a gel phase which is not dispersed on dilution, some soluble nucleoprotein is also present. The soluble component has been isolated by centrifugation and the distribution of the sedimentation coefficients of deoxyribonucleic acid present has been determined. As shown in Fig. 1*c*, the distribution covers a range of lower sedimentation coefficients than does the distribution for the deoxyribonucleic acid in the gel phase. If the nucleoprotein gel is allowed to stand at 4° C., it eventually becomes fluid. The loss of the high viscosity is accompanied by a progressive shift of the deoxyribonucleic acid distribution curve to lower values of sedimentation coefficients (Fig. 1*c*), suggesting that the deoxyribonucleic acid is being slowly degraded, probably by a small amount of deoxyribonuclease present in the preparation. Further experiments confirmed that nucleoprotein is susceptible to degradation by deoxyribonuclease, the addition of a small amount of the enzyme to the gel causing a much more rapid loss of viscosity than was observed for the gel alone and a correspondingly more rapid shift of the distribution to lower values of sedimentation coefficients.

These results suggest that some degradation of the deoxyribonucleic acid occurs before or during the isolation of the nucleoprotein from the thymus tissue, producing the soluble component of the nucleoprotein. It seems probable that degradation of the deoxyribonucleic acid at these early stages of the preparation may be the major cause of the variations observed between different preparations of the acid made by the detergent method, since no evidence of degradation or fractionation has been observed in this process of preparation of it from the nucleoprotein. Degradation of the deoxyribonucleic acid during the preparation of the nucleoprotein would also produce breaks in the single strands of the twin helix such as have been postulated to explain the decrease in molecular weight observed on heating deoxyribonucleic acid solutions[10].

This investigation has been supported by grants to the Chester Beatty Research Institute (Institute of Cancer Research: Royal Cancer Hospital) from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service.

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Delayed Effect of Ipsilateral Intracarotid Infusion of Sodium Chloride on the Composition of the Parotid Saliva of Sodium-depleted Sheep

SHEEP with permanent unilateral parotid fistulæ may be maintained in good health indefinitely provided that sufficient sodium bicarbonate is added to the daily dietary intake to compensate for that lost in the hypertonic alkaline parotid saliva. It has been shown[1] that withdrawal of this supplementary sodium intake causes sodium depletion and, as depletion increases, the ratio of sodium to potassium in the parotid saliva falls progressively from a normal value of 180 : 10 to as low as 10 : 180. This response to sodium depletion is not significantly affected by changes in the potassium intake. Restoration of the dietary sodium bicarbonate supplement, in an amount sufficient to correct the sodium depletion, causes the composition of the parotid saliva to return to normal.

During the investigation of this aspect of parotid secretion, we have observed the effect of infusing a concentrated solution of sodium chloride into the ipsilateral carotid artery of sodium-depleted sheep. This caused, after a time delay of 100–150 min., a rapid increase in the ratio sodium/potassium of the parotid saliva. The rise occurred only if the infusion caused a significant change in the sodium balance of the animal.

The details of the experiments are as follows. In addition to a left parotid fistula, each sheep had a carotid loop in the neck on the same side[2]. Sodium depletion was produced by withholding or reducing the supplementary sodium bicarbonate. The degree of sodium depletion varied in the several experiments; but the ratio sodium/potassium of the parotid saliva was in all cases less than 1·0 on the day of the infusion. The procedure for sodium chloride infusion was essentially that described by Verney[3], with the modification that the experiment was performed during constant stimulation of the gland by the infusion of acetylcholine (1 : 50,000 in 5 per cent dextrose at the rate of 0·5 ml./min.) into the carotid loop. This acetylcholine infusion caused an abrupt and sustained increase in the rate of parotid salivary secretion as well as an increase in the ratio sodium/potassium to approximately unity. After a base-line period of 2–4 hr., during which the rate of parotid salivary secretion settled down to a relatively constant rate of 2–4 ml./min., and there was no further change in the ratio sodium/potassium, the sodium chloride solution was infused. This was made up to a concentration of 4 molar in distilled water, and infused into the carotid loop at a rate of 0·4 or 1·60 ml./min., using a motor-driven syringe. The saliva from the fistula was collected directly into a stainless steel tray, and the animal was conscious and unrestrained throughout the experiment.

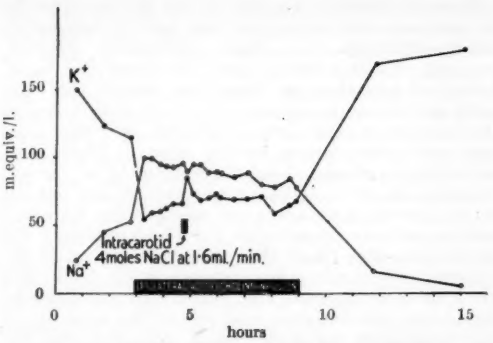

Fig. 2. Parotid fistula sheep No. 19, depleted of sodium. No change in the salivary sodium and potassium concentrations occurred after the rapid ipsilateral intracarotid infusion of 64 m.equiv. of sodium chloride (4·0 molar at 1·6 ml./min.)

In the first experiments, a total amount of 200–300 m.equiv. of sodium was infused over a period of 30–40 min. In most instances this caused an immediate small rise in the parotid salivary sodium concentration which persisted only until the end of the sodium chloride infusion. There was usually a fall in the rate of the salivary secretion during this period; but recovery occurred immediately after the infusion ceased. The ratio sodium/potassium in the saliva then returned approximately to the base-line level until 100–150 min. after the commencement of the infusion, when there was a rapid and progressive rise (Fig. 1). This was observed in three experiments in which the 4 *M* sodium chloride infusion was given at the rate of 1·60 ml./min., and in five other experiments in which approximately the same amount was infused at one-quarter that rate. The delay period was always at least 100–150 min. after the start of the sodium chloride infusion. As the total loss of sodium in the saliva during each experiment was, up to the time of the infusion, only about 60 m.equiv., the infusion caused a significant change in the sodium balance of the animal.

Two experiments were made on sheep similarly prepared, in which the sodium chloride infusion was given at the rate of 1·60 ml./min., but for a period of only 10 min., so that the amount of sodium infused approximately equalled the amount lost in the parotid saliva during the experiment. No delayed change in the sodium/potassium ratio of the saliva occurred (Fig. 2).

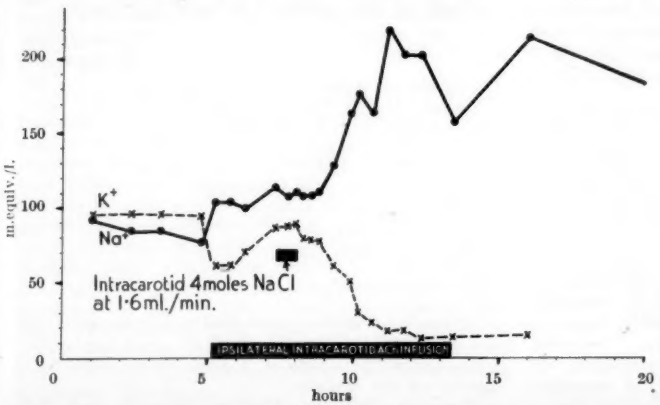

Fig. 1. Parotid fistula sheep No. 16, depleted of sodium. The delayed change in the saliva sodium and potassium concentrations after the rapid ipsilateral intracarotid infusion of 240 m.equiv. of sodium chloride (4·0 molar at 1·6 ml./min.)

Thus the delayed response to the sodium chloride infusion occurred only when the sodium balance of sodium-depleted sheep was significantly altered. Analysis of blood taken from the transverse facial artery of anæsthetized sheep has shown that the sodium concentration rises by 7–35 m.equiv./l. during the infusion of 4 *M* sodium chloride at these rates into the corresponding carotid artery. These considerations indicate that the return to a normal value of the ratio sodium/potassium in the parotid saliva was not due to a direct effect of the increased sodium ion concentration in the blood perfusing the gland. It seems likely that the site of action of the infused sodium ions was elsewhere in the body, and the time delay suggests that either a specific humoral agent was elaborated in response to the infusion, or the production of some agent necessary for the maintenance of a low salivary sodium/potassium ratio was inhibited. Investigation is proceeding to determine the site of the responsive region in the body, and the specific way in which changes in sodium balance may influence it. This experimental procedure, using a conscious undisturbed animal, should be of value in studying the biological regulation of sodium, since a change of sodium balance induces in the sensitive tissue a response of large magnitude on a short time-scale.

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Effect of Cadmium Salts on Testicular Tissue

The physiological action of cadmium salts has been studied extensively by many authors. Morphological disturbances have been described in various organs (liver, kidney, etc.). While studying the effect of cadmium salts on protein metabolism one of us (J. P.) observed that cadmium chloride administered subcutaneously to rats produces macroscopic lesions of the testes. This seems to have escaped the notice of previous authors and therefore this phenomenon was studied more closely.

Mature male rats weighing on an average 300 gm. were given 1 ml. 0·03 *M* aqueous solution of cadmium chloride or lactate subcutaneously between the shoulder-blades. Male rats injected with an equimolar solution of sublimate served as controls together with normal animals. Rats were killed 2, 4, 6, 8, 10, 12, 24 and 48 hr. after injection. Already 2–4 hr. after injection of cadmium chloride, capillary stasis and œdema of the interstitium could be observed microscopically. 8 hr. after injection extensive hæmorrhages developed. Occasionally leucocyte infiltration, which was rarely massive, occurred. Regressive changes of spermiogenic epithelium developed 4–6 hr. after the injection of cadmium chloride (desquamation of cells, pycnosis of nuclei, karyorrhexis and lysis of nuclei). 24–48 hr. after injection all testicular tissue was severely damaged.

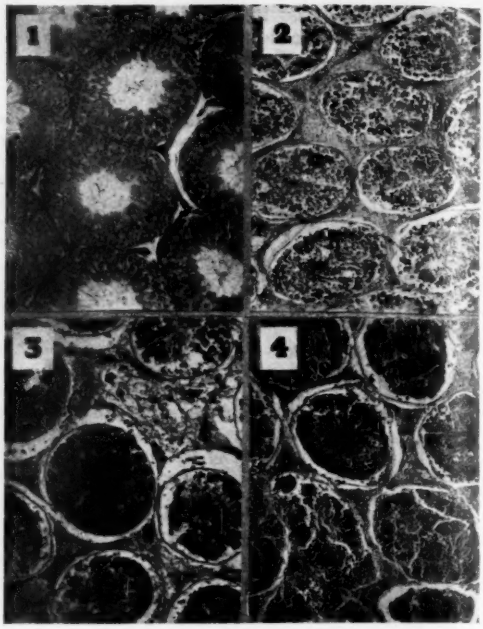

Fig. 1. Sublimate 48 hr. after application. Rat testis of normal appearance. Fig. 2. Cadmium chloride, 48 hr. after application. Collapse of tubules, œdema of intertubular spaces, desquamations and pronounced degenerative changes of the spermiogenic epithelium. Fig. 3. Cadmium lactate, 48 hr. after application. Histological picture as in Fig. 2. Fig. 4. Cadmium chloride, 12 days after application. Total necrosis of testicular tissue. (Bouin, hæmatoxylin-eosin; × *c.* 60)

On the following days all nuclear remains disappeared and complete testicular necrosis set in. Cadmium chloride and lactate have the same effect, whereas sublimate does not produce any obvious histological changes in the testes. Morphological lesions in the ovaries of female rats after cadmium chloride administration were not observed; but functional changes cannot be excluded. The changes described were found in the testes of all animals tested (80 males), whereas changes in other organs were only slight, except in the liver, where they varied in extent.

Work on this problem is being continued.

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It has been shown (preceding communication) that the subcutaneous application of small amounts of cadmium salts results in a rapid destruction of all tissues of the testicle.

Recently, Elcoate, Fischer, Mawson and Millar showed that prolonged nutritional deficiency of zinc causes testicular injury[1]. It may be asked whether

the effect of cadmium on testicular tissue is not comparable to the effect of a lack of zinc, the former being rapid and sudden. In our experiments it was possible to protect testicular tissue of adult rats completely from the destructive effect of cadmium (0·04 m.mole cadmium chloride/kgm. body-weight subcutaneously) by the simultaneous administration of 80, 100 and 200 times the amount of zinc, injected in the form of acetate subcutaneously in divided doses before, simultaneously with, and after, application of cadmium.

Of all soft tissues, spermatozoa (and the prostate) contain the largest amount of zinc. Turnover of zinc is greatest in the testes[2]. Cadmium and zinc are physico-chemically very close to each other. It is therefore attractive to speculate that cadmium displaces zinc from those molecular structures into which zinc is probably incorporated during the maturation of spermatozoa. In view of the fact that it has been possible to suppress the destructive effect of cadmium on the testis by using many times the dose of zinc, a mechanism of competitive inhibition between these two metals may be suggested.

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Action of an Autolytic Enzyme of *Bacillus subtilis* on the Cell Wall

Many biologically produced substances are known to lyse living micro-organisms. Among them, lysozyme has been studied most extensively for the mechanism of its action, and it has been shown that this action is the dissolution of cell wall, probably the hydrolysis of mucopolysaccharide contained in it[1]. Studies on the action of autolytic enzymes, on the other hand, are few, and their site of action has not hitherto been known. Recently, one of us observed very rapid autolysis of amylase-producing strains of *Bacillus subtilis*[2] and isolated an autolytic substance(s) from the lysate[3]. Studies on this autolytic substance(s) have shown that it lyses the cell wall.

An autolytic enzyme preparation was obtained from the lysate of *B. subtilis H* by precipitation with ammonium sulphate. Cell-wall preparation was obtained from the same bacterium. Washed cells were disrupted by boiling at 100° C. for 10 min. and, further, by exposure to supersonic vibration. Disrupted cells were digested successively with crystalline trypsin, crystalline *B. subtilis* protease and crystalline chymotrypsin. The residue seemed to consist mainly of cell wall when examined in the electron microscope. As shown in Fig. 1, this cell-wall preparation was dissolved by the autolytic enzyme solution (crystalline lysozyme also dissolved it, but crystalline ribonuclease had no effect). Electron microscope examination also confirmed this result.

Further investigation of the mechanism of lytic action was undertaken against living bacteria. Recently, Weibull[4] succeeded in dissolving the cell wall only, by the controlled treatment with lysozyme in sucrose, and obtained protoplast. The protoplast of our strain, *B. subtilis H*, was also formed by treatment with lysozyme in the presence of 10–15 per cent sucrose or polyethylene glycol. Therefore, the effect of high concentrations of these substances on the lytic action of the autolytic enzyme solution was examined. Complete protection was observed during the first 1–2 hr., but thereafter lysis occurred and action seemed to take place in two steps: the dissolution of the cell wall, and disruption and lysis of the resulting protoplast. When the enzyme solution was heated at 100° C. for 10 min., the autolytic activity was completely abolished. This boiled solution was added to the cell suspension in sucrose (15 per cent) together with the lysozyme solution. Complete lysis occurred, whereas only protoplast formation was observed without boiled enzyme solution. Therefore it was concluded that this enzyme solution contains a heat-stable substance(s) which causes the disruption of the protoplast in addition to the heat-labile enzyme which dissolves the cell wall.

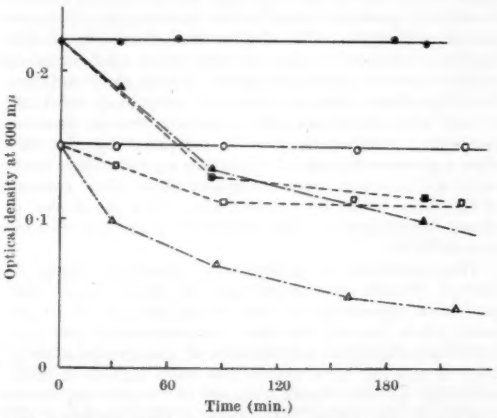

Fig. 1. Action of the autolytic enzyme solution and lysozyme on the cell-wall preparation. The cell-wall preparation was suspended in *M*/30 phosphate buffer, mixed with the autolytic enzyme solution or lysozyme solution as indicated. Total volume, 6 ml., *p*H 7·2. Rate of dissolution at 30° C. was followed by measuring the changes of optical density at 600 mμ

Set 1: ●—●, control; ■—■, plus 1 ml. autolytic enzyme solution; ▲·—·▲, plus 3 ml. autolytic enzyme solution. Set 2: ○—○, control; □—□, plus lysozyme 0·67 γ/ml.; △·—·△, plus lysozyme 6·7 γ/ml.

In view of these and other results, it seems reasonable to conclude that the primary site of action of this autolytic enzyme solution is the cell wall, probably the polysaccharide contained in it (polysaccharide was isolated from the cell and its depolymerization by this enzyme solution was demonstrated (unpublished results)). A more detailed account of this work will be published elsewhere.

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Effect of Carbon Dioxide on the Manganese Absorption of Red Beet Tissue

In an earlier publication[1] the discovery was reported of a substance extractable by water from red beetroot and capable of inhibiting the active accumulation of manganese by slices of storage tissue. It was suspected at the time that the substance might be produced by the dark fixation of respiratory carbon dioxide which, as Burton[2] showed for potatoes, may reach concentrations of about 7 per cent in bulky storage organs. I have now shown that the presence of carbon dioxide in solutions from which beetroot tissue slices are absorbing manganese reduces the rate of absorption. The reduction in rate is proportional to the concentration of carbon dioxide up to about 40 per cent, at which the rate appears to be minimal.

When slices of beetroot tissue are freed from natural inhibitor by prolonged washing in running water, inhibition of salt absorption capacity can again be produced by exposing the tissues to carbon dioxide in gaseous form before placing in the manganese solutions. The degree and duration of this condition depend on the concentration and duration of exposure to carbon dioxide. These facts support the hypothesis that a naturally occurring inhibitor of salt absorption may be a carbon dioxide fixation product. Further support is provided by the fact that a greater degree of inhibition results when beetroots are stored at temperatures of about 25° C. instead of the more usual 10° C., and when they are stored in closed containers so that respiratory carbon dioxide accumulates.

The exposure of inhibitor-free beetroot tissue to carbon dioxide concentrations of about 3 per cent (or short exposures to concentrations up to 10 per cent) when oxygen was the complementary gas produced a subsequent stimulation of manganese absorption on placing in solutions free from carbon dioxide, although higher concentrations or longer exposures produced the usual inhibition. This suggests the possibility of the formation of another fixation product or the oxidation of the inhibitor to form a metabolic stimulant. It is hoped that full results will be reported elsewhere.

Dale and Sutcliffe[3] question the significance of a water-extractable inhibiting substance in connexion with the dormancy of stored beetroot or the development of a capacity for salt absorption in slices of cut tissue, and they claim that the observations of Skelding and Rees were due to the presence of relatively indiffusible anions such as malate and citrate in the extracts. This may well have been the case, although Dale and Sutcliffe quote no figures for the organic acid content of their tissue extracts to support it. The results reported above are, however, consistent with the formation in beetroot tissue of an inhibiting substance, and the formation of acids by carbon dioxide fixation in plant tissues is well known. It could be the case that the presence of organic acids in the cytoplasm in certain concentrations is inhibitory; but if so the explanation would more probably lie in a specific action of the acid on absorption centres rather than in the presence of an ion of low mobility in the external solution. The effect of externally applied malate might also be on absorption centres. If the hypothesis put forward here as to the reason for the undoubted low level of salt absorption capacity in newly cut storage tissue is correct, an inhibiting substance may well be of significance in the life of tuber-forming plants.

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A Selective Medium for the Isolation of Basidiomycetes

In the course of a programme of work involving the isolation of wood-rotting fungi from infected Scandinavian wood-pulp, considerable trouble was experienced with rapidly spreading mould contaminants, particularly *Trichoderma viride*[1]. In many cases, attempts to isolate Basidiomycetes from stains known to be caused by these fungi failed, due not only to the growth of *Trichoderma* which in a short time covered the surface of the malt agar medium, but doubtless also to secretion of the antibiotics viridin and gliotoxin by this mould, which are active against many fungi[2]. Experiments have shown that *Trichoderma* isolated from wood-pulp is able to retard, and in some cases prevent, the growth in artificial culture of various Basidiomycetes.

This difficulty has now largely been overcome in these laboratories by the development of a selective medium containing 0·006 per cent *o*-phenyl phenol, which has given good results both when used for the isolation of wood-rotting fungi from wood-pulp and also, in conjunction with an air-sampling apparatus, from the air in a pulp mill. The latter work was done in an attempt to demonstrate the presence of Basidiomycete diaspores in the aerial microflora of a Norwegian pulp mill, and was very successful. Using the selective medium, *Fomes annosus* was isolated from several locations together with four other (at present unidentified) Basidiomycetes. None was obtained by exposing plates of normal malt agar.

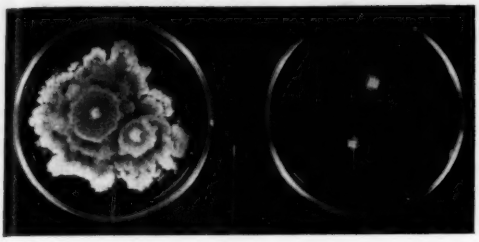
The selective medium has the following composition:

'Oxoid' desiccated malt extract	3 gm.
'Oxoid' mycological peptone	0·5 gm.
Agar-agar	2·5 gm.
o-Phenyl phenol	0·006 gm.
Distilled water	100 ml.

The medium is autoclaved at 10 lb./in.² for 10 min. The required amount of *o*-phenyl phenol is added from a stock solution prepared by dissolving 1 gm. in 50 ml. industrial alcohol. This solution is diluted to 100 ml. with distilled water and is quite stable.

Extensive tests have been carried out with this medium. We have found that several Basidiomycetes isolated from wood pulp will grow, albeit slowly, in media containing up to 0·01 per cent w/v of *o*-phenyl phenol. The growth of bacteria can at the same time be prevented by the normal method of lowering the *p*H of the medium to about 3·5 with sterile lactic acid, without affecting the selective action of the *o*-phenyl phenol towards Basidiomycetes.

At a concentration of 0·006 per cent *o*-phenyl phenol, certain moulds (for example, *Cladosporium* sp., *Alternaria* sp., *Penicillium* spp.) will produce restricted colonies after about a fortnight on the medium. Also, from one pulp sample, a strain of



(1) (2)

Fig. 1. Contiguous fragments of infected wood-pulp on normal and selective malt agar. (1) Only *Trichoderma* growing. (2) *Trichoderma* suppressed, Basidiomycete isolated

Trichoderma was isolated which was highly resistant to *o*-phenyl phenol. Nevertheless, the medium has proved to be sufficiently valuable to be used in the routine examination of infected wood-pulp.

In general, the micro-fungi appear to be much more sensitive to this chemical than the Basidiomycetes normally encountered in this work. (The only wood-rotting fungus so far observed which failed to grow on the medium was *Merulius lacrymans*.) The concentration of *o*-phenyl phenol can apparently be increased somewhat if desired, and it is thought that the medium could be used with advantage in the isolation of Basidiomycete fungi from soil, materials frequently heavily infected with superficial moulds such as wood-pulp and bark, building boards, freshwater, pulp mill whitewaters and the air.

Fig. 1 illustrates the result of placing infected fragments of wood-pulp, taken from adjacent positions, on normal and selective malt agar plates. Complete suppression of *Trichoderma*, which was sporing freely on the pulp, has been obtained with the selective medium, and the Basidiomycete responsible for the rot-stain under examination has been successfully isolated.

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[1] Russell, P., *Nature*, **176**, 1123 (1955).
[2] Ainsworth and Bisby, "A Dictionary of the Fungi".

Incorporation of Carbon-14 into the Complex Polysaccharides of Plants

The carbon-14 tracer technique would appear to offer a unique opportunity for investigations of the biosynthesis and subsequent metabolism of pectins and hemicelluloses, provided that there is a measurable synthesis and turnover of these polysaccharides in plant tissues. After allowing four mature fruiting spurs, each with four to six leaves and two fruits, detached from plum trees (variety Victoria), to photosynthesize[1] in the presence of carbon-14 dioxide (from 43·5 μc. barium carbonate-^{14}C), the leaf polysaccharides and the water-soluble polysaccharides of the fruit mesocarp were isolated. Labelling of all the monosaccharide constituents was observed by hydrolysing the polysaccharides (*N* sulphuric acid; 100°; 16 hr.), separating the products on paper chromatograms and examining with a Geiger counter those areas containing the separated sugars. The specific activities of the latter were determined, after elution from the paper chromatograms, as infinitely thin films on planchets (see Table 1). The incorporation of carbon-14 into the fruit mesocarp polysaccharides may be due to photosynthesis by the fruit or by translocation from the leaves.

Table 1

Monosaccharide	Specific activity (counts/min./mgm.)	
	Leaf polysaccharides	Mesocarp polysaccharides
Galacturonic acid	882	20
Galactose	1,342	31
Glucose	3,110	—
Arabinose	334	11
Xylose	180	—
Rhamnose	184	—

The highly active glucose undoubtedly arose from leaf starch. Clearly, the complex polysaccharides are biosynthesized in the leaf and mature plum fruit tissues, thus suggesting the existence of a dynamic equilibrium between these polysaccharides and their monosaccharide constituents in a manner analogous to the animal proteins. Jermyn and Isherwood[2] have made an analytical study of the cell-wall polysaccharides of pear fruit at various stages of ripening, with the conclusion that certain of the polysaccharides were being synthesized in over-ripe fruit. The synthesis of complex polysaccharides in mature fruit tissues is contrary to the classical view.

This work forms part of the programme of the Food Investigation Organization of the Department of Scientific and Industrial Research.

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[1] Livingstone, L. G., and Medes, G., *J. Gen. Physiol.*, **31**, 75 (1947).
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Mitochondrial *Nebenkern* of the Water-boatman

During the past few years, in the course of an investigation of the chemical composition of the acroblasts ('Golgi apparatus') in the spermatogenesis of the water-boatman (*Notonecta glauca*), I have been impressed by the structure of the mitochondrial *Nebenkern* of this animal. The male germ-cells of *Notonecta* are very large, the spermatozoon being more than a centimetre long, and the *Nebenkern* is probably the largest single body of mitochondrial origin that occurs in any organism. Its development and subsequent history were worked out long ago by Pantel and de Sinéty[1], Poisson[2] and Voïnov[3]. It is formed by the fusion of the mitochondria present in the young spermatid.

The purpose of this communication is to direct attention to the curious resemblance between the internal structure of this *Nebenkern* as seen by the light-microscope, and that of the ordinary mitochondrion as revealed in recent years by the electron microscope. Fig. 1 represents a section of the *Nebenkern* of the young spermatid of *Notonecta*. It is seen to be traversed by flat partitions, which show at

20 μ

Fig. 1. The ovoid *Nebenkern* in the young spermatid of *Notonecta glauca*. Twelve partitions can be counted. (Fixed in Mann's fluid; paraffin section stained in Hirschler's hæmatoxylin)

20 μ

Fig. 2. Two elongating spermatids of *Notonecta glauca*. *a*, Acrosome in its vesicle; *b*, group of acroblasts; *neb*, elongating *Nebenkern*, now divided in two; *nu*, nucleus. (Weigl's method; unstained 4-μ section)

least some superficial resemblance to the cristæ mitochondriales of the electron microscopists. The scale of the objects is, however, extremely different. The mean distance from the middle of one partition to the middle of the next, in the *Nebenkern*, is about 1,600 mμ; in the ordinary mitochondrion the corresponding distance is commonly about 30–60 mμ (see, for example, Sjöstrand and Rhodin[4]). Sections passing at various angles through the *Nebenkern* show that the partitions are not arranged in the same way as the cristæ; nevertheless, it is interesting that a laminated structure exists in both objects.

In the later spermatid the *Nebenkern* divides in two and each half elongates (Fig. 2). The laminated structure is now much less evident.

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Leafhopper Transmission of a Clover Virus causing Green Petal Disease in Strawberry

The symptoms of green petal disease[1] of strawberries in Britain resemble those caused by the aster yellows virus[2] in strawberries in California. In several localities where the disease occurs in Kent, symptoms of the aster yellows type were also found in red and white clover (*Trifolium pratense* L. and *T. repens* L.), plantain (*Plantago major* L.) and mayweed (*Anthemis cotula* L.).

In the search for vectors of green petal virus, collections of mixed species of leafhoppers from herbage in and near strawberry fields were caged on diseased plantain and clover plants for approximately three weeks. The insects that survived represented only two species, *Euscelis lineolatus* Brullé and *Macrosteles viridigriseus* (Edwards) (determined by Dr. D. A. Young, U.S. National Museum, Washington, D.C.); to test them as vectors they were transferred to successive plants of red clover, white clover, celery, mayweed, plantain, *Fragaria vesca* L. and *Duchesnea indica* Focke. In the first tests large numbers of insects were fed on each test plant; later, single insects were transferred to young seedlings of crimson clover (*T. incarnatum* L.).

Mixed colonies of *E. lineolatus* and *M. viridigriseus* infected nine out of twelve clover, four of six mayweed, and one of three celery test plants. In separate tests with the two species of leafhoppers, *E. lineolatus* colonies infected nine of fourteen clover plants, and a further nine transmissions occurred with single insects. As plantain proved to be a better host than clover for *M. viridigriseus*, most of the insects of this species were fed on plantain test plants; these have developed such mild symptoms in the glasshouse that diagnosis of virus infection is uncertain. Only one definite transmission, to mayweed, has occurred with *M. viridigriseus*.

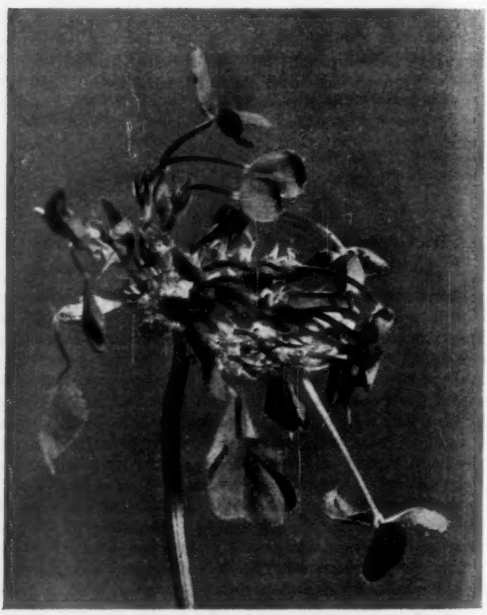

Fig. 1. Virus-induced phyllody in white clover flowers on plant infected by *Euscelis lineolatus*

Both species failed to infect the strawberry and *D. indica* test plants, and the relationship between the leafhopper-transmitted virus and green petal disease was determined by transmission effected by dodder. *Cuscuta subinclusa* D. and H. transferred the virus from clover to strawberry and *D. indica* plants, which developed the characteristic leaf and flower symptoms of green petal disease. Strawberry plants of the variety Lassen produced identical flower symptoms whether infected by dodder from clover or by grafting to green petal-infected strawberry.

The general similarity in symptoms and host-range, and in the resistance shown by strawberry to experimental infection by leafhoppers, suggests that green petal disease may be caused by a strain of the aster yellows virus. There are, however, differences in symptoms on all hosts, implying a distinction between the green petal and both the eastern and the western aster yellows viruses.

The frequent occurrence of the disease in isolated strawberry fields suggests that the green petal virus may be widespread in clover. The prominent phyllody of the clover flowers (Fig. 1) should have directed attention to this disease, but it may have been attributed to damage by *Dasyneura* midges or phytoptid mites. Infected red clover plants are stunted, with yellow leaf margins and veins, and a proliferation of axillary buds. White clover, although developing clear symptoms, seems less sensitive than red, many plants of which have been killed within a few months of infection.

This is the first virus shown to be transmitted by leafhoppers in Britain.

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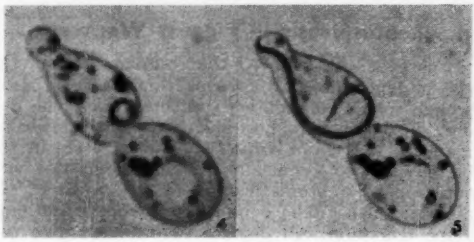
Cytoplasmic Structures in Yeasts

Yotsuyanagi[1] has reported long, curved, cylindrical, occasionally branched, thread-like mitochondria in yeast cells by staining with tetrazolium. Although mitochondria are often clearly visible in living yeast cells, no other observer has ever reported long cylindrical cytoplasmic structures in *Saccharomyces*; we believe these thread-like structures are crystals of dye rather than mitochondria.

Figs. 1, 2 and 3 show a yeast cell at three optical levels after 15 min. staining with 2,3,5 triphenyl tetrazolium. The mitochondria in Fig. 1, in central focus, are darkly stained structures with clear centres, showing that the dye is deposited on the outside of the mitochondrion. Fig. 2 shows the same structures in low focus as dark spots; a deposit of tetrazolium is forming. Fig. 3 shows the same cell in high focus; the stained mitochondria appear as light areas due to the refraction of light by the granules. One hour later (Fig. 4) the deposit is much darker. After another hour (Fig. 5) a crystal of tetrazolium extends across the cell. It is probably structures like this which Yotsuyanagi[1] and Ephrussi and Slonimski[2] have mistaken for mitochondria. In other cells crystals of dye appear as plates or short broad rods.



Ephrussi and Slonimski[2] and Yotsuyanagi[1] have proposed that three kinds of cytoplasmic granules are present in yeasts: (1) long cylindrical threads, (2) refractile granules which they do not think are mitochondria and (3) small 'true' mitochondria.

We have shown that deposits of formazan, especially the thread-like structures, are dye crystals, not resembling any normal structure present in the yeast cell.

This work was supported by a grant from the American Cancer Society administered by the Committee on Growth, National Research Council.

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The above comment on our papers starts with the assertion that "Yotsuyanagi has reported long, curved, cylindrical, occasionally branched, thread-like mitochondria in yeast cells by staining with tetrazolium". This is incorrect; the thread-like mitochondria referred to were stained with janus green and with Altmann's fuchsin. The observation of Williams, Lindegren and Yuasa that "deposits of formazan, especially the threadlike structures, are dye crystals not resembling any normal structure present in the yeast cell" is therefore irrelevant.

On the other hand, Williams *et al.* state: "Ephrussi and Slonimski and Yotsuyanagi have proposed that three kinds of cytoplasmic granules are present in yeasts: (1) long cylindrical threads, (2) refractile

granules which they do not think are mitochondria and (3) small 'true' mitochondria". Our papers show, however, that the small granular and the long thread-like mitochondria represent, in our opinion, two physiological states of the chondriome.

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Leptospirosis in Piggery Workers

It is generally believed that human cases of the type of leptospirosis known as canicola fever arise through man's contact with infected dogs, the dog being the only natural host and carrier of the infecting organism, *Leptospira canicola*. The infection in the dog may lead to a clinically recognizable disease with acute renal symptoms leading to the death of the animal; but a milder condition may occur and may escape detection. All degrees of infection give rise to the carrier state, which may persist for months or even years, during which time the leptospiras are expelled in the urine, which thereby constitutes a potential source of infection to other dogs and man.

Although the probable source of many human cases of canicola fever has been traced directly or indirectly to dogs, there have been instances where no connexion between patient and dog could be found. Four examples of such cases gave rise to an investigation into a possible alternative source of infection, the results of which present some interesting features. The patients concerned in these four cases, which arose during the years 1950–55, were all persons employed in piggeries situated within the City of Edinburgh. It seemed unlikely that the farm dogs were responsible for the infection, since they appeared healthy, and sera obtained from them failed to agglutinate *Leptospira canicola* to more than a low titre. In one of the piggeries where a single case had occurred, it was possible to obtain specimens of blood from all of the other human contacts living and working there, namely, three men and two women. Agglutination tests show that in four of these bloods, antibodies to *Leptospira canicola* were present in high titre—1/1,000 to 1/10,000. The one person whose blood failed to show any response to the agglutination test was the young wife, who was the only member of the household having no contact with the pigs.

Blood samples were taken from some of the pigs selected at random at the time of slaughter. Of seventy-six such specimens forty-six were found to have antibodies to *Leptospira canicola* giving titres of at least 1/100 (fifteen were 1/1,000 to 1/10,000). *Leptospira icterhaemorrhagiae* was agglutinated to a lesser degree. No antibodies to *Leptospira pomona*, *Leptospira hyos* or *Leptospira biflexa* were found in any of the samples tested.

These results indicate that pigs may become infected with a species of Leptospira closely related to, if not identical with, *Leptospira canicola*. If the responsible organism is indeed *Leptospira canicola*, the infection may have been introduced into the piggery in the first place by an infected dog, and once established there the infection has continued to spread directly from pig to pig.

To investigate the infectivity-rate among pig workers, blood specimens were obtained from forty-seven workers employed in twelve different piggeries (these figures include those already mentioned). Agglutination tests showed that nineteen (that is, 40 per cent) contained a high antibody content to *Leptospira canicola*—1/100 to 1/10,000. *Leptospira icterhaemorrhagiae* was agglutinated to a lesser degree.

An explanation of this apparently high infectivity-rate may be that the workers' hands are frequently contaminated with infected urine. The conditions of their work seem to predispose them to cuts and abrasions which do not heal readily. These injuries and the fact that the hands are often wet from frequent submersion in water will allow the leptospira to penetrate into the skin readily.

Further inquiry regarding the health of those workers whose bloods were positive to *Leptospira canicola* revealed that during the past five years, five of them had suffered from an illness diagnosed as canicola fever and, of the remaining fourteen, five had a history suggestive of the disease. No marked symptoms of disease in the pig have been observed, but leptospira have been seen in the urine.

Further work is in progress, and it is hoped that the results of the complete investigation will be published in detail elsewhere at an early date.

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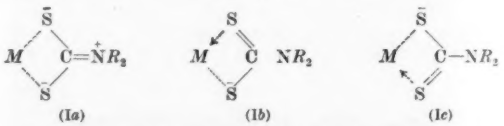
Electronic Structures of Dithiocarbamates and Xanthates

It has long been realized that the canonical form (I*a*) may contribute significantly to the structure of the dithiocarbamate residue in its complex compounds, $M(S_2CNR_2)_n$, where M is a metal atom and n its valency, but no physical or chemical evidence for this has yet been advanced.



(I*a*) (I*b*) (I*c*)

Recently, van der Kerk and his co-workers[1,2] have suggested that (I*a*) contributes strongly to the structure of methyl derivatives (R = Me) but that its importance decreases rapidly on ascending the homologous series. They consider the dipolar form (I*a*) to be responsible for the antifungal and plant-growth promoting properties of certain derivatives of NN-dimethyldithiocarbamic acid. Since the biological activities of the NN-dialkyldithiocarbamate derivatives fall rapidly on ascending the homologous series, they conclude that the contribution of the form (I*a*) to the structures also falls rapidly. At the time of their later publication[2], we had examined the infra-red spectra of a number of complex NN-dimethyl- and NN-diethyldithiocarbamates and interpreted the so-called 'thioureide ion' band[3] in terms of the canonical form (I*a*). This band had previously been identified in many thioureides but not satisfactorily interpreted[3,4]. Van der Kerk's publication

prompted us, however, to extend our investigation to higher homologues and to organic derivatives. We now report briefly our conclusions.

In general, we find that the forms (I*a*), (I*b*) and (I*c*) contribute about equally to the structures of all NN-dialkyldithiocarbamic acid derivatives, and that there is no significant decrease in the importance of the form (I*a*) on ascending the homologous series. The canonical form of type (I*a*) probably contributes about equally strongly to the structures of the N-monoalkyldithiocarbamates, but only in a comparatively minor way to the structures of the xanthates.

Our evidence for this is based on an infra-red spectral investigation of some thirty derivatives of NN-dialkyldithiocarbamic acid, and on the dipole moments of some unsymmetrical derivatives. The types of compounds examined included salts, for example, $Na(Me_2NCS_2)$, complex salts, for example, $Co(Et_2NCS_2)_3$, an ester, Me_2NCS_2Me, and a sulphide $(Me_2NCS_2)_2$. All have a strong absorption band, the 'thioureide ion' band, in the 1,542–1,480 cm.$^{-1}$ region of the spectrum, usually around 1,500 cm.$^{-1}$. It is too high in frequency to be due to a vibration, the form of which is largely determined by stretching of a single C—N bond, or of a double C=S bond[3]; its frequency is also too high for it to be assigned to a deformation mode of the methyl groups[4], for this would not occur at frequencies greater than 1,480 cm.$^{-1}$. The only possible assignment appears to be to a polar C—N double bond, and this implies that the canonical form (I*a*) makes an important contribution to the ground-states of all NN-dialkyldithiocarbamates.

If this conclusion is correct, unsymmetrical derivatives of dialkyldithiocarbamic acids should have large electric dipole moments, because the form I(*a*) is highly dipolar. Most complex dithiocarbamates presumably have centro-symmetrical structures, but those of type $As(R_2NCS_2)_3$ must be unsymmetrical, because arsenic(III) has a lone pair of electrons; the esters R_2NCS_2R must also be unsymmetrical. In fact, the dipole moments of these two types of derivatives are high, of the order 4·5–5·0 and 3·0 Debye units respectively[5]. To account for these moments in the esters the C—N bond must have a bond order of 1·25–1·35, that is, the forms (I*a*), (I*b*) and (I*c*) contribute about equally to the structure.

The unsymmetrical N-alkyldithiocarbamates have similar dipole moments to the corresponding NN-dialkyldithiocarbamates[5], and the spectra of the few monoalkyl derivatives which we have examined all have an absorption band in the 1,500 cm.$^{-1}$ region. Apparently their electronic structures are similar to those of the NN-dialkyldithiocarbamates.

The unsymmetrical xanthates have comparatively low moments of less than 2 Debye units in the cases of $As(ROCS_2)_3$, and of the esters, $ROCS_2R$[5]. These are of the same order as those of the symmetrical complex dithiocarbamates[5], xanthates[5] and acetylacetonates[6]. We have therefore examined the spectrum of $Ni(EtOCS_2)_2$, and find that it is transparent in the double-bond region[7]. There is a broad band at 1,265 cm.$^{-1}$ which is in the right place for an unsaturated ether[8]. We conclude, therefore, that the canonical form $—\bar{S}_2C=\overset{+}{O}R$ contributes comparatively little to the structure of the xanthates.

In view of the suggestion of van der Kerk and his co-workers, we examined a homologous series of copper NN-dialkyldithiocarbamates. Our observations are recorded in Table 1. It is evident that the C=N frequency is almost independent of the size of the alkyl groups, and such change as we observe in the solid state is mainly due to crystal forces. It appears that the observations of van der Kerk and his co-workers cannot be explained as due to the much greater contribution of form (I*a*) to the structures of the lower homologues. Perhaps increasing lipoid- or decreasing water-solubility may provide an explanation of the decreasing biological activity as the series is ascended.

Table 1. C=N STRETCHING FREQUENCIES (cm.$^{-1}$) OF CUPRIC NN-DIALKYLDITHIOCARBAMATES, $Cu(R_2NCS_2)_2$, IN CHLOROFORM SOLUTION (± 2 cm.$^{-1}$) AND IN THE CRYSTALLINE STATE

R	Me	Et	Pr^n	Bu^n	Pr^i
Solution	insol.	1,505	1,502	1,505	1,490
Solid	1,524	1,508	1,501	1,497	1,493

The greater contribution of the canonical form of type (I*a*) to the structure of the dithiocarbamates than to that of the xanthates undoubtedly arises from the greater mesomeric electron-releasing tendency of the $—NR_2$ group as compared with the $—OR$ group. In the dithiocarbamates, this greater electron drift into the sulphur atoms will increase their electron donor capacity, and decrease the electron affinity of their *d*-orbitals as compared with the sulphur atoms in the corresponding xanthates. Thus the dithiocarbamate ion should form stronger complexes, with less tendency to dative π-bond formation from the metal to the sulphur atoms, than the xanthate ion. This may well provide some explanation of the rather striking differences between the chemistry of the complex dithiocarbamates and complex xanthates[9].

Full details of this work will be published elsewhere.

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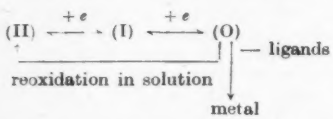
Formation and Reduction of Zero-Valent Metal Complexes studied Polarographically

IN the course of the reduction of inorganic compounds the electron is always accepted by the lowest unoccupied (or singly occupied) orbital in the depolarizing particle, regardless of whether this orbital is localized in the central metal atom (or some ligand-atom) or whether it is an unlocalized molecular orbital. After the acceptance of the electron, a rearrangement of electrons and ligands takes place leading to the most stable configuration

of the particle with one more electron formed in the reduction. The rate and mechanism of the electrode process depend on the rate and mechanism of this rearrangement.

The electronic structure of the particle determines whether the acceptance of the first electron will cause a great rearrangement, leading in some cases to the decomposition of the particle, or whether the second electron can be accepted immediately.

The reduction of transition metal ions in oxidation stage + 2 is a special case of the latter mechanism[1]. The inner *d*-orbitals of these ions are not fully occupied by electrons localized in the metal atom, and the electron can be accepted by these orbitals during the reduction. In complexes with most ligands, the ion in oxidation stage + 1 thus formed is sufficiently stable to accept the second electron while forming a complex containing the metal in the zero oxidation stage. The rearrangement or decomposition of the particle does not take place until the second electron has been accepted. The zero-valent complex may either decompose, yielding the metal, or reoxidize to a complex of a higher oxidation stage. This mechanism can be illustrated by the following scheme:



The mechanism of the chemical reactions of the zero-valent complexes may be complicated (for example, due to dismutation).

The formation of metal complexes in low oxidation stages has been demonstrated during the reduction of nickel (II)-complexes. The height of the reduction wave of the ion $Ni(CN)_4^{2-}$ corresponds to the acceptance of two electrons per nickel atom. During the reduction of $Ni(CN)_4^{2-}$, a red colour and the evolution of hydrogen at the electrode surface are observed. This effect can be ascribed only to the oxidation of the ion $Ni(CN)_4^{4-}$, formed as a primary product of the electrode reaction, to the ion $Ni_2(CN)_6^{4-}$, which is not reducible. Other experiments support this conclusion. The oscillopolarographic curves for dV/dt versus V (Fig. 1) point to one reversible redox process, corresponding to the reversible reduction of $Ni(CN)_4^{2-}$ and oxidation of $Ni(CN)_4^{4-}$; and also to one irreversible anodic process, corresponding to the oxidation of the ion $Ni_2(CN)_6^{4-}$, formed by the reaction of $Ni(CN)_4^{4-}$ with water. Polarography with the Kalousek commutator[2] points to the same processes. The form of the reduction wave of the ion $Ni(CN)_4^{2-}$ is in agreement with the proposed mechanism and may be deduced theoretically. The height of the cathodic wave of $Ni(CN)_4^{2-}$ in solutions with higher concentration of cyanide ions or in acid solutions is greater than would correspond to a two-electron process. This increase of current can be ascribed to the regeneration of the ion $Ni(CN)_4^{2-}$ by oxidation of $Ni(CN)_4^{4-}$ ion with water.

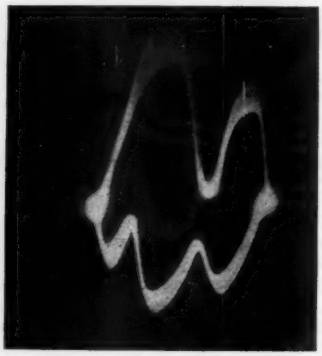


Fig. 1. Oscillographic curve for dV/dt versus V of $Ni(CN)_4^{2-}$ in 0·1 *M* sodium cyanide

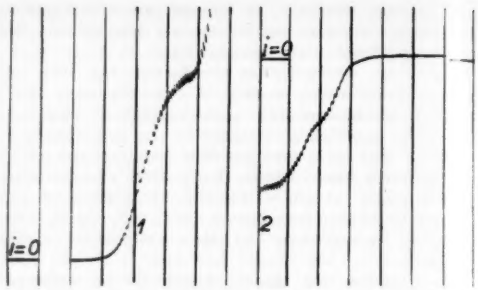


Fig. 2. Polarographic curves of $Fe(CO)_5$ and $Fe(CO)_4^{2-}$. Curve 1: $1·5 \times 10^{-3}$ *M* $Fe(CO)_5$, from −1·2 V. (satd. cal. elect.), 205 mV./absc. Curve 2: 1×10^{-3} *M* $Fe(CO)_4^{2-}$, from −0·3 V. (satd. cal. elect.), 150 mV./absc. Electrolyte: 0·3 *M* $(CH_3)_4NCl$, absolute ethanol; nitrogen atm., $S = 1·50$

These experiments show that the ion $Ni(CN)_4^{2-}$ is not reduced to the metal, as stated by Hume and Kolthoff[2], but to the ion $Ni(CN)_4^{4-}$, which is quickly inactivated by a chemical reaction. Partial deposition of metallic nickel was observed only in acid solutions. The decomposition of the ion $Ni(CN)_4^{4-}$ in acid solution is caused by the tendency to form undissociated molecules of hydrogen cyanide.

The complexes of nickel (II) with dipyridyl, ethylenediamine, pyridine, ammonia and chlorides (in 5 *M* calcium chloride), were also shown to be primarily reduced to zero-valent complexes of nickel, which are very rapidly decomposed to the metal or oxidized to a higher oxidation stage. The life-time of these zero-valent complexes is shorter than 0·01 sec.

From the study of nickel (II)-complexes, it follows that the formation of zero-valent complexes as a primary product of electrode reaction is very probable in the reduction of the complexes of all transition metals in oxidation stage + 2 with ligands which are not easily reducible. By the assumption of the formation of low-valent metal complexes, many catalytic effects of transition metals at the dropping mercury electrode, especially the Brdička reaction, can be explained.

The stable zero-valent metal complexes with *d*-orbitals not fully occupied by electrons localized in the metal atom can be further reduced at the dropping mercury electrode. An example of this behaviour is the reduction of iron pentacarbonyl, which gives in ethanolic solution a well-developed reduction wave at − 1·7 V. (satd. calomel electrode) (Fig. 2), followed by a large catalytic current at − 2 V. The height of the reduction wave corresponds to two electrons for each iron atom. The product of the reduction is the ion $Fe(CO)_4^{2-}$, as was demonstrated by polarography with the Kalousek commutator. The ion $Fe(CO)_4^{2-}$ is oxidized at the dropping mercury electrode in two successive steps (Fig. 2)

to some compound of zero-valent iron different from $Fe(CO)_5$ and $Fe_3(CO)_{12}$, as could be again demonstrated by the Kalousek commutator.

This work will be described in detail elsewhere.

A. A. Vlček

Polarographic Institute of the
Czechoslovak Academy of Science,
Prague.
March 12.

[1] Vlček, A. A., *Chem. listy*, **49**, 479 (1955); *Coll. Czech. Chem. Comm.*, **20**, 894 (1955); *J. Electrochem. Soc.*, **102**, 354 (1955).
[2] Kalousek, M., *Chem. listy*, **40**, 149 (1946); *Coll. Czech. Chem. Comm.*, **13**, 107 (1948).
[3] Hume, D. M., and Kolthoff, I. M., *J. Amer. Chem. Soc.*, **72**, 4423 (1950).

Improving the Characteristics of the Cyclotron Beam

Reports[1] of existing fixed-frequency cyclotrons indicate that near the maximum energy the ratio between internal and external beam current is about five to one, with the maximum current limited by heating of the septum by the stray beam. If the internal beam could be more accurately aligned at the deflector and the stray beam removed, a larger external beam, better focused and with less energy-spread, could be produced.

In the cyclotron, groups of particles leaving the ion source become bunched in phase[2] and, given a stable dee voltage, would follow nearly the same path, arriving at the deflector after the same number of turns. It is not usual to provide such stability, and many cyclotrons operate with quite a large mains ripple. This produces a range of conditions at the deflector. For example, if there is a 6 per cent ripple on the dee voltage, different groups of particles may do between 66 and 74 turns. The energy and position of particles within a single group are nearly the same. Due to precession of the particle orbits, however, the energy and position, and hence the extraction efficiency, may differ widely from one group to the next.

Theory indicates that stabilization of the dee voltage to some 0·25 per cent would improve the characteristics of the beam. The reduction in both energy-spread and angular spread would then make it easier to focus on remote targets, while selection of the optimum particle group would give increased extraction efficiency. There would be a further advantage; a beam which follows a single path to the deflector makes it possible to place beam-defining slits on the dee interface. By intercepting the stray particles, particularly those which would strike the sides of the deflector, these slits should collimate the beam and increase the extraction efficiency still further.

A vertical slit has been tried near the ion source on the Medical Research Council's 45-in. cyclotron and found to produce a corresponding narrowing of the beam at larger radii. The sides of the slit can be made to intercept any portion of the first turn without impeding the succeeding one, while the proximity of the slit to the dees seems to have no adverse effects. It is expected that in the final arrangement the slit near the ion source will be about $\frac{1}{4}$ in. wide by $\frac{3}{4}$ in. high and situated at $1\frac{1}{2}$ in. radius, with a second slit $\frac{1}{4}$ in. wide, giving finer adjustment, placed just before the deflector. The beam current striking the two sides of this second slit could provide a convenient way of stabilizing the voltage.

The theory, which will be submitted for publication elsewhere, is based upon numerical plots of the first turns, precession calculations, study of the extraction conditions, and upon calculations[3] on the phase excursion through the machine. Some confirmation of the correctness of the theory is apparent in a report[4] on experiments with the internal beam of the University of Birmingham cyclotron. In this report stops are suggested for the reduction of beam pulse-length.

This work was done in connexion with the construction of the Medical Research Council's 45-in. cyclotron. I wish to thank Mr. J. W. Gallop for his interest and encouragement and also Mr. D. D. Vonberg and Mr. P. J. Waterton for many helpful discussions.

W. B. Powell

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Jan. 5.

[1] Gallop, J. W., "Notes on a Tour of American Fixed Frequency Cyclotrons in the Autumn of 1950".
[2] Bohm, D., and Foldy, L., *Phys. Rev.*, **72**, 649 (1947).
[3] Vonberg, D. D., Internal Technical Memorandum No. 17.
[4] Konrad, M., Ph.D. thesis, University of Birmingham.

Adsorption Spectrum of Nitrogen on Tungsten

It has recently been shown[1] that even at low coverages of a fraction of a monolayer, nitrogen is simultaneously adsorbed on tungsten in different states of binding, of which three have so far been isolated. The temperatures above which these individual species are unstable have been estimated semi-quantitatively as 800° K. for state α, 2,000° K. for β and 200° K. for γ. In order to define the spectrum of binding energies of the molecular species adsorbed on the surface, it is necessary to measure the concentration of adsorbed entities as a function of sorbent temperature. We have now been able to do this by a simultaneous recording of the rise in pressure and the increase in electrical resistance when the tungsten

Fig. 1 (*a*). Desorption of nitrogen from tungsten with increasing temperature; filament initially at 298° K. Temperature range 298°–2,000° K. The instantaneous pressure is proportional to the amount of gas desorbed

(*b*). Desorption of nitrogen from tungsten initially at 298° K. Temperature range 298°–1,000° K.

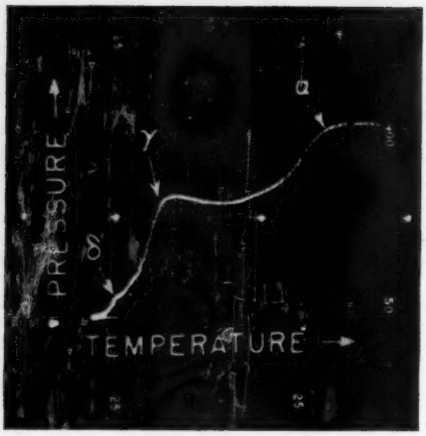

Fig. 2. Desorption of nitrogen from tungsten filament initially at 80° K. Temperature range 80°–750° K.

wire sample is heated in a flash-filament cell. Since the variation of electrical resistance of tungsten with temperature is known, the flash filament can be used both as adsorption sample and resistance thermometer.

In our system the pressure is monitored by an inverted ion gauge, the ion current from which is amplified with a vibrating-reed electrometer and displayed as ordinate on a cathode-ray oscilloscope. The adsorption filament is made one arm of a 10-kc./s. bridge, so that a change in filament temperature results in an unbalance which can be recorded on the abscissa of the oscilloscope[2]. Fig. 1 shows the resulting pressure vs. temperature plot for nitrogen adsorbed on a tungsten filament initially held at 298° K.; here the increase in the pressure (above the base line) corresponding to a given temperature is proportional to the total number of molecules evolved up to that temperature. Two regions over which desorption occurs are very clearly defined. After an initial evolution of gas only slightly above room temperature (the α-peak), desorption stops; for the initial stages of adsorption the material in the chemisorbed β-peak only begins to be evolved at 1,400° K., and is completely removed at 1,900° K. Fig. 1*b* gives an enlarged view of the low-temperature region of the burst, showing the α-peak alone, desorption of which appears to be complete at 650° K.

The details of adsorption in states of low binding energy are revealed in Fig. 2, showing a pressure vs. temperature trace for a filament cooled with liquid nitrogen to an initial temperature of 80° K. It appears that in addition to the α- and γ-peaks previously reported[1], a fourth level, δ, contributes significantly to adsorption at this low temperature. The temperature-ranges over which evolution of gas occurs are: level α, 300–650° K.; β, 1,400–1,900° K.; γ, 140–250° K.; δ, 100–140° K. We estimate a heat of desorption of approximately 85 k.cal. for nitrogen in state-β; the interactions in the other levels are significantly lower, and for γ and δ are presumably of the same order as commonly found in physical adsorption.

It has already been shown that nitrogen in state-α does not appear to participate significantly in the increase in population of state-β which can be observed with time[1]. Preliminary measurements, which will be reported in greater detail at a later date, indicate that at $T = 80°$ K. there is no significant exchange between levels γ and β, but that exchange between δ and the other levels does occur.

Gert Ehrlich
T. W. Hickmott

General Electric Research Laboratory,
Schenectady,
New York.
Dec. 14.

[1] Ehrlich, G., *J. Chem. Phys.*, **23**, 1543 (1955); and in the press.
[2] An adsorption spectrometer, utilizing a d.c. bridge circuit, has been described by Hagstrum, H. D., *Rev. Sci. Instr.*, **24**, 1122 (1953).

The Prefix 'Nor' in Chemical Nomenclature

In his review of the new edition of "The Extra Pharmacopoeia" (Martindale), Vol. 2, Prof. J. H. Gaddum (*Nature*, Feb. 25, p. 350) states, "surely *nor* means 'N ohne Radikal' and not 'the next lower homologue' ". I have seen this explanation of the prefix 'nor' given several times in medical publications but never in a chemical text-book, and I suspect that "N ohne Radikal" is a mnemonic invented by a German pharmacologist to assist his students to remember the constitutions of *nor*adrenaline, *nor*ephedrine and similar compounds. However this may be, the fact remains that the prefix *nor* is used for many compounds which contain no nitrogen at all; for example, *nor*pinic acid, *nor*œstrone, *nor*equilenin, etc. The statement made in Martindale is therefore perfectly correct.

It might be, of course, that this is simply an extension of the original use of the prefix 'nor', which certainly does not appear to be derived from Latin or Greek.

A. M. Woolman

Eichenstrasse 7,
Arlesheim.

The first use of the prefix 'nor' appears to be in a paper by Matthiessen and Foster[1] published in 1868. They were studying the nitrogen-free substance opianic acid formed by the oxidation of narcotine and obtained evidence that it contained two methyl groups. They had used the term 'normal opianic acid' to mean the completely demethylated compound, and they then used the contraction 'methylnoropianic acid' for the monomethyl derivative. Since that time the prefix has generally been used to denote the replacement of one or more methyl groups by H, or the disappearance of CH_2 from a carbon chain, but its use may leave the resulting structure in doubt. I apologize for supporting a false etymological theory.

J. H. Gaddum

Pharmacological Laboratory,
University,
Edinburgh 8.

[1] Matthiessen, A., and Foster, G. C., *J. Chem. Soc.*, 358 (1868).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, June 4

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. E. R. Hamilton: "Education in Nigeria".*

Tuesday, June 5

WRIGHT-FLEMING INSTITUTE OF MICROBIOLOGY (at St. Mary's Hospital Medical School, London, W.2), at 5 p.m.—Prof. C. H. Stuart-Harris: "Recent Studies in Acute Respiratory Disease"* (Almroth Wright Lecture).

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (in the Main Chemistry Lecture Theatre, Imperial Institute Road, London, S.W.7), at 5.30 p.m.—Prof. Geoffrey Wilkinson: "Inorganic Chemistry—Some Views on the Renaissance" (Inaugural Lecture).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.30 p.m.—Sir Lawrence Bragg, F.R.S.: "Atoms and Molecules". (Lecture for Fourth Form Pupils.) (Further Lecture on June 6.)

Wednesday, June 6

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. R. M. Shackleton: "Downward-facing Structures of the Highland Border"; Dr. R. J. Firman: "Fissure Metasomatism in Volcanic Rocks Adjacent to the Shap Granite".

Thursday, June 7

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. H. Charnock, Mr. J. R. D. Francis and Mr. P. A. Sheppard: "An Investigation of Wind Structure in the Trades—Anegada 1953".

MINERALOGICAL SOCIETY (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—General Meeting.

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. G. T. Seaborg (University of California): "Present Status of the Transuranium Elements" (Centenary Lecture).

Friday, June 8

BRITISH SOCIETY FOR RESEARCH ON AGEING (at the Ciba Foundation, 41 Portland Place, London, W.1), at 4 p.m.—Annual General Meeting. 4.30 p.m.—Mr. K. J. Franklin, Mr. S. B. Carter and Mr. P. J. Lindop: "Examples of Reactions to Standard Stimuli at Various Ages"; Mr. H. B. Fell: "Effect of Vitamin A on Embryonic Epidermis of Different Ages".

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in the Department of Psychology, Birkbeck College, Malet Street, London, W.C.1), at 6 p.m.—Symposium on "Psychology and Design".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Mr. Eric Newton: "The Relationship between Form and Content in the Arts".

Saturday, June 9

BRITISH PSYCHOLOGICAL SOCIETY (in the Gustave Tuck Theatre, University College, Gower Street, London, W.C.1), at 2.30 p.m.—Prof. G. J. Renier: "No Man's Land: In Defence of the Borderline Worker".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ENGINEERING—The Registrar, University College, Cardiff (June 8).

LECTURER IN MATHEMATICS, and a LECTURER IN PHYSICS, at Fourah Bay College, Sierra Leone—The Secretary, Advisory Committee on Colonial Colleges, 1 Woburn Square, London, W.C.1 (June 8).

ASSISTANT EXPERIMENTAL OFFICER (with a university degree in botany, zoology or microbiology and some training in chemistry) IN THE MARINE LABORATORY, Aberdeen, for duties which consist of the maintenance of algae cultures and assistance in research on the physiology of marine algae—The Establishment Officer, Scottish Home Department, Room 364, St. Andrew's House, Edinburgh 1 (June 9).

ASSISTANT EXPERIMENTAL OFFICER (with G.C.E. advanced level in mathematics and physics, and an interest in the mathematical treatment of data) IN THE DEPARTMENT OF SCIENTIFIC AND INDUSTRIAL RESEARCH, Ditton Laboratory, near Maidstone, Kent, for work on engineering and physical problems of refrigeration applied to food preservation—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting C.359/6A (June 9).

LECTURERS (Grade II) (2) IN THE DEPARTMENT OF PHYSICS—The Registrar, The University, Birmingham 15 (June 9).

PHYSICISTS (2) (one with experience in electronics and the other in radiotherapy), to work in a laboratory engaged in experimental and routine work for the medical staff—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (June 9).

LABORATORY STEWARD IN THE DEPARTMENT OF PHYSICS at the University College of Rhodesia and Nyasaland—The Secretary, Inter-University Council for Higher Education Overseas, 29 Woburn Square, London, W.C.1 (June 11).

LECTURER and ASSISTANT LECTURER (with special qualification in organic chemistry) IN CHEMISTRY—The Registrar, The University Manchester (June 11).

LECTURER IN THE DEPARTMENT OF MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (June 11).

RESEARCH STUDENT (with an honours degree in sociology, psychology or anthropology) to undertake research on educational problems in the Centre for the Study of Education—The Registrar, University College of the West Indies, Mona, Jamaica (June 11).

RESEARCH ASSISTANT (preferably with an honours degree in botany and specialized in mycology) for work on potato gangrene—The Secretary, North of Scotland College of Agriculture, 41½ Union Street, Aberdeen (June 15).

TUTORIAL STUDENTS IN BIOCHEMISTRY, BOTANY, CIVIL ENGINEERING, GEOLOGY, MATHEMATICS, PHYSICS, PHYSIOLOGY and ZOOLOGY—The Registrar, King's College, Strand, London, W.C.2 (June 15).

ASSISTANT LIBRARIAN (graduate in pure or applied science and some experience in a scientific or technical library) IN THE SCIENCE AND TECHNOLOGY SECTION of the University Library—The Librarian, The University, Edmund Street, Birmingham (June 16).

BIOCHEMIST or ORGANIC CHEMIST (with either medical qualifications or a suitable chemistry degree) IN THE PATHOLOGY DIVISION of the Pneumoconiosis Research Unit of the Council for Scientific and Industrial Research—The Director, South African Institute for Medical Research, P.O. Box 1038, Johannesburg, South Africa (June 16).

LECTURER IN PSYCHOLOGY—The Joint Clerk to the University Court, College Gate, St. Andrews (June 16).

READER IN APPLIED THERMODYNAMICS in the University and HEAD OF THE DEPARTMENT OF MECHANICAL ENGINEERING in Robert Gordon's Technical College—The Secretary, The University, Aberdeen (June 16).

DEMONSTRATOR IN THE SCHOOL OF CHEMISTRY—The Registrar, The University, Leeds 2 (June 18).

LECTURER IN CIVIL ENGINEERING—The Registrar, The University, Sheffield (June 18).

LECTURER IN APPLIED MATHEMATICS—The Secretary, The University, 38 North Bailey, Durham (June 20).

INORGANIC CHEMIST or FUEL TECHNOLOGIST (with a university honours degree in science with inorganic chemistry as a major subject or in fuel technology, and preferably with research experience) IN THE COAL RESEARCH SECTION, Commonwealth Scientific and Industrial Research Organization, North Ryde, Sydney, N.S.W., Australia, to undertake research into problems relating to dew-point and deposit-forming phenomena connected with the burning of Australian coals as part of general investigations into the efficient utilization of these coals—Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2 (June 22).

DEMONSTRATOR IN THE DEPARTMENT OF GEOLOGY—The Registrar, University College of North Staffordshire, Keele, Staffs (June 23).

EXPERIMENTAL OFFICER (graduate in botany with an ecological background and experience or special interest in field botany and natural history, or equivalent qualifications) as ASSISTANT to the Regional Officer, East Anglia, based at Norwich, for duties which include assisting with biological surveys and management of nature reserves and other sites, liaison with Naturalists, Local Authorities, landowners and others, with some administrative work concerning general inquiries, conservation problems, issue of permits, etc.—The Establishment Officer, The Nature Conservancy, 19 Belgrave Square, London, S.W.1 (June 25).

ASSISTANT LECTURER or LECTURER (with a degree or diploma in horticulture and sound practical experience) IN HORTICULTURE, at Canterbury Agricultural College, University of New Zealand—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 30).

ASSISTANT or LECTURER IN STATISTICS—Joint Clerk to the University Court (University of St. Andrews), Queen's College, Dundee (June 30).

LECTURER IN THEORETICAL CHEMISTRY—The Registrar, University College of North Staffordshire, Keele, Staffs (June 30).

LECTURERS (3) IN MICROBIOLOGY—The Registrar, The University, Birmingham 15 (June 30).

SENIOR FELLOW IN THE DEPARTMENT OF GEOPHYSICS, Australian National University—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1 (June 30).

ASSISTANT DIRECTOR OF RESEARCH IN CHEMICAL ENGINEERING—The Secretary of the Appointments Committee, Department of Chemical Engineering, Tennis Court Road, Cambridge (July 7).

CHAIR OF PHYSICS in the University of Cape Town—The Secretary, Association of Universities of the British Commonwealth, 36 Gordon Square, London, W.C.1, and The Registrar, University of Cape Town, Private Bag, Rondebosch, Cape Town, South Africa (July 15).

LECTURER IN BIOCHEMISTRY; LECTURER IN PSYCHOLOGY; LECTURER IN ORGANIC CHEMISTRY; and a LECTURER IN PHYSICAL CHEMISTRY—The Registrar, University of Adelaide, Adelaide, South Australia (July 16).

SENIOR PROFESSIONAL OFFICER (with a university degree in science or engineering or equivalent qualification, and a minimum of four years research or industrial experience in refractories or ceramics) for duties which are concerned with the testing and investigation of ceramic materials of South African origin—The Director, Government Metallurgical Laboratory, University of the Witwatersrand, Milner Park, Johannesburg, South Africa (July 31).

SENIOR and JUNIOR RESEARCH FELLOWS (with a first- or second-class honours degree in an appropriate subject, and able to show evidence of a very high standard of ability in research) at Government Scientific Establishments for research into subjects of importance to H.M. Government—Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S.4567/56 (October 31).

ASSISTANT, Grade A, to teach pure and applied mathematics; and an ASSISTANT, Grade A, to teach physics—The Principal, Technical College, Queen Street South, Huddersfield.

ASSISTANT LECTURER IN PHYSICS (Grade B); a LECTURER IN MATHEMATICS, and an ASSISTANT LECTURER IN MATHEMATICS (Grade B)—The Secretary, Sir John Cass College, Jewry Street, London, E.C.3

BIOCHEMIST, to work on meat; and a CHEMIST and PHYSICIST, to work on fats—The Director of Research, British Food Manufacturing Industries Research Association, Randalls Road, Leatherhead, Surrey.

CHAIR OF AIRCRAFT ECONOMICS AND PRODUCTION—The Recorder, College of Aeronautics, Cranfield, Bletchley, Bucks.

DEPUTY DIRECTOR (with a good honours degree in metallurgy and prepared to live in the Cambridge area) OF RESEARCH—Director of Research, British Welding Research Association, 29 Park Crescent, London, W.1.

HOSPITAL PHYSICIST (Senior grade) IN THE DEPARTMENT OF RADIOTHERAPY, Essex County Hospital, Colchester, for work with X-ray therapy apparatus and radium—The Group Secretary, Hospital Management Committee, 14 Pope's Lane, Colchester, Essex.

LABORATORY ASSISTANT (with some skill in glass-blowing)—The Secretary, Rothamsted Experimental Station, Harpenden, Herts.

LECTURER IN AGRICULTURAL CHEMISTRY (Animal Nutrition), and a LECTURER (with a degree in science or agriculture) IN AGRICULTURAL ZOOLOGY—The Bursar, Harper Adams Agricultural College, Newport, Salop.

LECTURER (with good academic qualifications and experience in the food industry) IN FOOD SCIENCE—The Secretary, Royal Technical College, Glasgow.

MATHEMATICIANS (with, or obtaining, a first- or second-class honours degree) at various Ministry of Supply Experimental Establishments, for work in numerous fields of interest, including aerodynamic and structural problems arising in supersonic flight; application of mathematical techniques to control and heat transfer problems of guided missiles; radio propagation; application of high-speed computing techniques to fluid dynamics and solid-mechanics, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), 26 King Street, London, S.W.1, quoting A.198/6A.

NUCLEAR PHYSICIST (Group Leader) (with a first-class honours degree in physics and research experience in the study of ionized gases), to lead a team in the field of controlled thermonuclear reactions—The Senior Recruitment Officer, Atomic Weapons Research Establishment, Aldermaston, Berks, quoting 1165/34.

RESEARCH ASSISTANT (with qualifications in mathematics, physics or chemistry, and preferably with experience of large-scale computing) IN THE DEPARTMENT OF INORGANIC AND STRUCTURAL CHEMISTRY, to be a member of a small group engaged in preparing programmes for, and carrying out, extensive crystallographic and other scientific calculations on electronic digital computers—Prof. E. G. Cox, School of Chemistry, The University, Leeds 2.

RESEARCH SCHOLARS and FELLOWS IN THE TEXTILE DEPARTMENT—The Principal, Technical College, Bradford 7.

SENIOR LECTURER IN PHYSICS—Northern Polytechnic, Holloway, London, N.7.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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